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THE AGRICULTURAL MACHINERY INDUSTRY: AN APPRAISAL OF THE CURRENT GLOBAL SITUATION PRODUCTION AND MARKET OUTLOOK

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Preface

This study has been prepared by UNIDO's Division for Industrial Studies, Sectoral Studies Branch. It presents an appraisal of the current production and market situation for the world's major producers of agricultural machinery. Specific emphasis is put on the situation in the developing countries.

The study will be a background document to the Second Consultation on the Agricultural Machinery Industry to be held in October 1983. The statistical material is issued in a separate statistical compendium in order to facilitate references. All reference to numbered tables refer to that statistical compendium (Volume II of this study).

The study draws on a number of input documents and external data sources. A special survey of the Latin American Region is issued simultaneously as another bac..ground document to the Consultation under the title "A Survey of the Latin American Agricultural Machinery Industry" (UNIDO/IS.407). Other background studies may be issued subsequently as Sectoral Working Papers.

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EXPLANATORY NOTES

References to dollars ($) are to United States dollars; constant dollars are expressed at 1975 pricess, obtained be deflating the current values by the geographically most appropriate export price index of agricultural machinery, published in the United Nations Monthly Bulletin of Statistics.

A billion is 1,000 million

A comma (,) is used to distinguish thousands and millions.

A full stop (.) is used to indicate decimals.

A slash between dates (e.g., 1980/81) indicates a crop year, financial year or academic year.

Use of a hyphen between dates (e.g., 1960-1965) indicates the full period involved, including the beginning and end years.

Metric tons have been used throughout.

The following forms have been used in tables:

Three dots (...) indicate that data is not available or is not separately reported.

A dash (-) indicates that the amount is nil or negligible.

A blank indicates that the item is not applicable.

Totals may not add up precisely because of rounding.

Besides the common abbreviations, symbols and terms and those accepted by the International System of Unites (SI), the following abbreviations and contractions have been used in this report:

Economic and technical abbreviations

GDP	Gross domestic product
GFCF	Gross fixed capital formation
AMP	Agricultural Machinery Production, Gross
ISIC	International Standard Industrial Classification of all Economic Activities
MVA	Manufacturing value added
R and D	Research and Development
SITC	Standard International Trade Classification

Organizational abbreviations

ASEAN	Association of South East Asian Nations
UN	United Nations
UNIDO	United Nations Industrial Development Organization
FAO	Food and Agriculture Organization
UNCTAD	United Nations Conference on Trade and Development
ILO	International Labour Office
ECE	Economic Commission for Europe
IIASA	International Institute for Applied Systems Analysis
GATT	General Agreement on Tariffs and Trade
OECD	Organization for Economic Co-operation and Development
CEMA	Comité European des Groupement de Constructeurs du Machinisme Agricole

Introduction

The first global consultation meeting on the agricultural machinery industry organized by UNIDO in 1979 addressed the basic question on how agricultural mechanization in developing countries could contribute towards solving two fundamental problems:

(1) How to provide food for a world population that will reach 6.2 billion in the year 2000, 5 billion of which live in countries where the average food intake is already inadequate.

(2) How to employ this population and stabilize it in rural areas to prevent further anarchic growth of the major urban centres in the developing world.

In recognition of the fact that these problems have a special importance in the African countries, UNIDO in collaboration with FAO, organized a regional consultation meeting on the agricultural machinery industry in Addis Ababa in 1982. The documentation for the African consultation called for radically new policies and strategies and analyzed in depth the realities of the situation.[1/] New strategies and action programmes were developed and a basis for a plan of action was suggested.

The second global consultation on the agricultural machinery industry is convened at a time when the world industry is going through a critical phase. The production of modern agricultural equipment is massively concentrated in the industrialized countries with developing countries accounting for only about 8 per cent of total world production through a handful of countries. While the basic requirements of most developing countries for mechanization of their agricultural sector cannot be met, producers of machinery in the industrialized countries experience falling production levels, declining profits and increasing unemployment. Domestic production in developing countries faces grave difficulties and producers in industrialized countries have so far not responded to the special needs of developing countries.

1/ Agricultural machinery and rural equipment in Africa: A new approach to a growing crisis, UNIDO/IS.377, March 1983

The main objective of the second consultation is to explore practical ways of resolving the present situation and overcoming some of the difficulties through international co-operation. The first issue to be considered has been formulated as "The world agricultural machinery industry, prospects for international co-operation" (see document ID/WG.400/3 and the background paper "Agricultural machinery industry in the 1980s, factors for international co-operation", ID/WG.400/1). The impact of the strategies of main producers on the prospects for co-operation, the relation between the evolution of different agricultural mechanization models and the future of the agricultural machinery industry and the role of governments in co-operation are topics to be considered under this issue.

The second issue concerns "The integrated manufacture of agricultural machinery and capital goods" (ID/WG.400/5 and background paper ID/WG.400/6) and links the manufacture of agricultural machinery with the related manufacture of capital goods through multi-purpose units suitable for the development of the engineering industry. The third issue deals with "Items to be included in model contracts for the import, assembly and manufacture of agricultural equipment including training; model licencing agreement" (ID/WG.400/4 and background paper ID/WG.400/2).

The present appraisal of the current global situation of the agricultural machinery industry as well as the simultaneously issued survey of the Latin American agricultural machinery industry[2/] aim at giving a broad-brush background analysis of trade and production in different regions of the world as well as a factual background to the discussion of the above-mentioned issues on international co-operation which have been selected for the consultation. The global appraisal reviews the present situation in the world industry and the major factors behind this situation. It discusses the response of the producers and the principal considerations behind possible industrialization strategies of the developing countries. An overview of the global production and trade, including a tentative projection of the consumption of agricultural machinery in the years 1990 and 2000, is followed by regional summaries trying to highlight this specific situation and the main problems in each world region.

2/ A survey of the Latin American agricultural machinery industry, UNIDO/IS.407

1. An Appraisal of the World Situation

The world situation in the agricultural machinery industry is characterized by low production levels, declining profits, and increasing unemployment in the dominating producer countries. At the same time there exists a huge potential demand for agricultural machinery in the developing countries. To a large extent this potential demand does not become effective due to low purchasing power of farmers. Repetition of heavy mechanization patterns of developed countries and the uninterest of producers in those countries to adapt their production to the requirements of developing countries aggravate the situation. National policies to stimulate domestic production of agricultural machinery in developing countries have more often than not been unsuccessful.3/

1.1 The present situation in the industry

The world agricultural machinery industry4/ has experienced a severe recession for several years running. This may have begun as early as 1977 or 1978 but became productionwise very serious around 1980-81 for most

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3/ See in this respect: UNIDO/IS.377, Agricultural Machinery and Rural Equipment in Africa - A New Approach to a Growing Crisis, and UNIDO/IS.407, A Survey of the Latin American Agricultural Machinery Industry.

4/ Throughout this study the agricultural machinery industry is defined as sectors belonging to the following groups of the International Standard for Industrial Classification (ISIC).

3811 Manufacture of agricultural handtools such as rates, hoes clippers, hand lawn movers.

3822 Manufacture of agricultural machinery and equipment, such as planting, seeding fertilizing, cultivating and harvesting equipment.

The corresponding trade statistics are reported under the headings listed in the SITC. Rev.1 as follows:

712.1 Agricultural machinery and appliances for preparing and cultivating the soil.

712.2 Agricultural machinery for harvesting, treshing and sorting.

712.5 Tractors, other than road tractors.

712.9 Agricultural machinery and appliances not elsewhere specified or included.

It is not possible to follow those definitions strictly and several deviations are indicated in the text and tables.

major producers. The decline in international trade generally lagged the reduction in production by one year. Of course, there has been individual deviations from this overall pattern both in terms of producers and products but mostly the market situation has been dismal. Very recently have some of the producers (mainly North American) began to show better profitability[5/] and the market outlook is expected to generally improve by 1984. One exception must be noted here. In 1981, Brazil managed to increase its exports to the other developing countries while other exporters started to experience heavy declines in their overseas sales. In fact, judging from the most recent available trade figures, no major slump in the trading performance of the developing countries occured in 1981 as compared to 1980. But, since the developing countries' share in trade (and production) of agricultural machinery is so small, their comparatively good performance did not substantially affect the global picture of the industry.

The world's agricultural machinery industry is heavily concentrated in the hands of a few countries and relatively few producers. The largest producer countries are the US, the USSR and Japan. In the developing countries, only Brazil, Argentina, India, Republic of Korea and China have significant domestic production of agricultural machinery (handtools and simple implements excepted). Mexico is emerging as a new important producer.

Because of the concentration of production in relation to the much more evenly spread demand, trade in agricultural machinery is substantial: approximately one third of the total world production is internationally traded. Therefore, too, production and exports are heavily correlated. Of the total exports, nearly 80 per cent originates from the developed market economies; five countries alone export two thirds of this total. Some

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5/ Massey-Ferguson's net losses during the second quarter of this year are down to $11.3 million compared to $87 million in the corresponding period last year. See Financial Times 1983-08-30, p.1. However, the improvement in profitability now is due to paying back of costs rather than to increased sales.

80 per cent of the developing countries' exports go to other developing countries, the majority of this being intra-regional trade from Brazil to other Latin American countries. The remaining 20 per cent is exported to the developed market economies. No exports to the centrally planned economies from the developing countries is registered.

The developing countries purchased one quarter of the world exports. More than 85 per cent of these imports came (in 1980) from the developed economies, 11 per cent from the centrally planned economies, and the remaining four per cent from other developing countries. Brazil is the only net exporter of agricultural machinery among the developing countries.

1.2 Major factors in the mechanization of agriculture

Since the 1950's the mechanization of agriculture has made rapid progress nearly everywhere. In the industrialized countries, the contributing factors to this development include:

- most available land is already in production;
- the value of farmland has increased;
- the average farm size has increased;
- the real cost of capital equipment in farming has increased;
- the availability of farm labour has declined;
- the development of agricultural machinery itself;
- agricultural policies that have made continuing overproduction financially feasible.
- technical evolution in the agricultural sector; and
  the development of the motor and automotive industries.

The implication of these factors is that the farmers have turned increasingly to an intensification of farming on their available lands as a primary strategy to increase the quantity and quality of agricultural production and thereby their incomes.

In the developing countries, the mechanization has proceeded much more slowly primarily due to:

- small farm sizes;
- topography and fragmentation of land;
- scarcity of skilled operators of mechanized farming equipment;
- population pressures;
- low effective demand for machinery;
- lack of appropriate machinery; and
- public policies intentionally or unintentionally biased against domestic agricultural production;
- lack of adequate infrastructure in the agricultural sector.

The implication of these factors is that while the farmers in the developing countries have realized the value of increased mechanization, their possibilities to purchase appropriate machinery have been very limited. Nonetheless, the need for an increased overall level of agricultural mechanization in the developing countries is strong and will have to be satisfied in order to reduce the so far widening gap between the growth in population and in food production.

1.3 Reasons for the current market situation

There are many important variables that argue for increased mechanization in the agriculture sector. Why, then, has the agricultural machinery industry experienced such a slow-down in the sales of its products?

In the developed market economies, the current market situation can be attributed to both domestic and international causes. On the domestic markets, major determinants are the worldwide recession, large crop production years further depressing already low farm commodity prices, increasing real prices for agricultural machinery, and an uncertain future of high interest rates and government support programmes. A prolongation of the usual machinery replacement cycle has not helped the machinery producers either but

this cause is probably related to the afore mentioned factors. In some of the smaller countries, a further development of collective utilization and leasing of equipment has reduced the rate of growth in the demand for agricultural machinery.

Since such a large portion of total agricultural machinery production in the developed market economies is exported, the external causes on the international markets are of great importance in this sector. Among the factors facing all, or nearly all, the exporting producers is foremost the worldwide recession which has caused total trade to languish and protectionist measures to proliferate to protect jobs at home. Other major common factors include the problems with distribution, service and parts supply which have not kept up with demand and caused some desillusion among potential buyers. The deteriorating balance of payment situation in many of the developed market economies is causing difficulties for not only the exporters but also for domestic producers who often rely on imported parts (often engines) to a varying degree.

Because of the recent large relative movements in the foreign exchange rates, the producers in different countries face different difficulties. The growing disparity between the dollar and the yen has had noticeable effects on the respective exports of USA and Japan. Italian and F.R. German producers have maintained their competiveness through currency adjustments and their traditional export orientation in specialized equipment. In fact, the smaller and more specialized manufacturers seem to have weathered the recession better than the giants in this industry. The producers in the UK have actually improved their international position through the lowering of the value of the pound and lower domestic inflation rate.

With respect to the markets in the developing countries, the major factors contributing to the depressed condition of the producers of agricultural machinery include:

- a deteriorating balance of payment situation making resources for the purchase of imports scarce;
- the increased debt burden in major importing countries making further credit very expensive, or even unavailable;

- continuing low incomes of farmers and fragmentation of available farm land;
- national policies intentionally or unintentionally biased agains domestic agricultural production.

An urban bias can be said to have characterized many national policies in the developing countries - more so in Africa and less so in Asia. This bias has clearly affected agricultural production and thereby the demand for agricultural machinery which, after all, is a derived demand. If the farmer does not experience an increased demand for this products, he has preciously little incentives to increase his production, i.e. to mechanize and improve productivity.[6/]

National policies have, by and large, failed in stimulating adequate domestic food production and in reducing the dependence on imports. Price structures and incentives have not been conducive to building up a profitable food producing sector.

In many developing countries, producer and consumer prices for basic foodstuff are controlled by the government. Dual objectives are pursued by these actions: adequate incentives for producers and protection of consumers are sought at the same time. In practice, the objective of ensuring adequate supplies of staples at "affordable" prices has been dominant. Thus, producer prices are fixed below market prices and imported foods are subsidized and encouraged when domestic food prices are increasing. Undoubtedly, this has a negative effect on domestic farmers and their willingness to produce and sell food on the local markets.

These policies have sometimes been attributed to an urban bias among policy makers in the developing countries.[7/] Yet the bias against agriculture and in favour of urban activities has largely failed to benefit

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6/ Cf. in this context UNIDO IS/377, op.cit.

7/ See for example, The World Bank, Accelerated Development in Sub-Saharan Africa, Washington D.C., 1981, p.26, and Shankor Acharya, "Development Perspectives and Priorities in Sub-Saharan Africa", Finance and Development, March 1981, pp.16 - 19.

industrialization in the long run. Slow growth of rural incomes in the predominantly agricultural economies of the developing countries meant slow expansion of the domestic market for manufactures. In Africa, where these policies have been subscribed to most heavily, food production per capita declined by 7 per cent between 1967 and 1978 whereas it increased by 7 to 8 per cent in Latin America and Asia.[8/] However, those African countries where the bias against agriculture has been the least pronounced are also the ones where the industrial sector grew faster between the early 1970 and 1979.

Other causes for the slow development of the agricultural sector in the developing countries include marketing systems that are inefficient, uncompetitive, and uncertain, as well as irregular supplies of necessary inputs including seeds and fertilizers but also fuel and parts for agricultural machinery.

In addition, the transportation system for transferring product to market has severely limited the amount of product that could be effectively marketed outside the immediate growing region.

Finally, droughts and poor rainfall patterns in the 1970's in many parts of the developing world, rapid population growth pushing cultivation into less productive areas (and less conducive to mechanization), and wars and civil strife have caused severe disruptions in agricultural production and thereby demand for agricultural machinery.

1.4 The producers' response

In response to the general market situation, the producers of the developed market economies have been looking at their own cost, production, and distribution structure rather than attempting to increase sales by adaptation to shifting market requirements e.g. through catering for the needs of the developing countries. This has meant lowering wage and salary bills, reducing inventories, work on improved manufacturing methods and lay-outs, tighter financial controls and relationships with suppliers, and in general

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8/ Ibid. p.17.

various attempts at cutting costs by rationalization pf the production. Responsibility for quality control has been transferred more towards the suppliers of components. Research and development has been stepped up by at least some of the major producers. Many have been operating their plants at less than capacity and have consolidated their operations to increase operating efficiency and capital utilization. Many production facilities have been temporarily or permanently closed. Tractor production in North America in the last quarter of 1982 was probably at only a fraction of full production capacity.

The share of world-wide employment of major North American producers employed in North America has steadily increased signalling a relative decline in overseas production. In fact, divestment of major interests in both European and Latin American subsidiaries have taken place recently.

The recession has forced the various manufacturers to further specialize their production and concentrate on the markets and products where they have a comparative advantage in terms of technology and foreign exchange rates.

North American firms are selling agricultural equipment to developing countries from their plants overseas to reduce the effect of the dollar's exchange value and bring the production closer to the markets. For example, John Deere manufactures its 55-59 HP tractor line in West Germany and markets to developing countries from there. Massey-Ferguson manufactures its medium and small (less than 100 HP) tractors in the United Kingdom and France. International Harvester manufactures in France, West Germany, and the United Kingdom, and assembles in New Zealand, Australia, and Mexico. J.I. Case acquired a British firm that manufactures small tractors to manufacture its 40-90 HP tractor line. Ford sells most of its tractors to customers outside North America from its European (France, Belgium, and the United Kingdom) and Brazilian plants. Not more than 5 per cent come from U.S. plants. As of now, there are few factories in the U.S. manufacturing tractors of less than 100 HP.

In the U.S., where the producers are hurt by increasing dollar values, leading producers in all sectors have increased their political pressure on the Administration to do something about the dollar/yen disparity in particular. Other responses of North American producers of agricultural

machinery to cushion against the effect of the high dollar and to reduce transportation costs include the selling of equipment to other countries directly from their overseas plants. Many firms have also increased their purchases of parts from overseas subsidiaries and licenses.

Many of the firms in the developed market economies are now entering into joint venture agreements with some developing countries and certain other innovative approaches, such as trade-and-barter schemes that accept counter-trade in exchange for exports, are tried out. In general, however, the developed countries' producers are not looking to solutions to their current problems with low demand that would involve the developing countries to any great extent. According to the industry itself, the product line produced in the developed countries for the developed country markets is so different from the machinery demanded in most developing countries that gearing up for those markets would involve major designing and re-tooling. This, it is argued, would require major investments which the industry is in no shape to undertake now and the resulting production series would be too short to achieve customary economies of scale. For example, for the European producers, the demand of the developing countries for agricultural machinery represents only some 10 per cent of total production. The Japanese manufacturers constitute an exception in this respect. Their production lines (compact tractors, combines and equipment suited for rice cultivation) find receptive markets among the developing countries. Japan is also eyeing the emerging huge Chinese markets and it is trying hard to increase its sales to the oil exporting Middle East countries with which it runs a constant trade deficit.

Political and other unrest in several traditional markets for the developed country producers of agricultural machinery have made them less attractive in the eyes of these manufacturers. Government interventions in the markets are also seen by these producers as uncertainty factors and thus have a negative effect on their perception of the markets in these developing countries. The response has been an abrupt withdrawal from these markets, except for in the case of direct sales of individual lots of machinery against guaranteed payment.

1.5 Policies for increased mechanization in the developing countries

Population growth is outstripping food production in many developing countries, in particular in Africa. Where output has increased, it is often due largely to an expansion of the areas under cultivation, except for the Indian subcontinent where much of the growth has come on irrigated lands. With the pressure of the growing populations on land, the traditional patterns of shifting cultivation, long fallow periods, manual farming using only primitive implements, and little use of fertilizers are becoming increasingly inappropriate. Over the past decade, it has been recognized that labour constraints are a key obstacle to agricultural progress but development strategies have not fully reflected this insight.[9/] Rather, the increase of the productivity of land through fertilizers and improved seeds has been stressed. Clearly, however, more emphasis should now be placed on increasing the productivity of labor through the greater use of farm implements, animal and machine powered cultivation, grain harvesting and processing equipment, and other equipment.

Although a great deal of agricultural machinery produced in the industrialized countries is sold or provided through development aid to the developing countries, we have seen that the companies strategies do not envision any expansion in this direction, with the notable exception of Japan. Thus, if the developing countries are to increase the level of mechanization of their agriculture, which they must, they will have to increase their own output of agricultural machinery.

To outline a detailed industrialization strategy for the manufacture of agricultural machinery is beyond the scope of this paper. Nonetheless, certain main elements deserve mentioning as a basis for discussions.

Principal considerations bearing on any such industrialization strategy are:

9/ Ibid., p.75.

(1) Market size. Although the farmers are numerous in the developing countries, their incomes are low and their holdings small and fragmented. Thus, the market in any given country or region tends to be small.

(2) Arable land. Many developing countries face a land constraint in the form of large areas being arid or semi-arid, mountainous, or covered by thick jungle. The cultivation of such lands requires specialized techniques and equipment that may not be easily transferrable. Soil conditions and the annual pattern of rainfall have similar effects.

(3) Wages and productivity. Wages in many developing countries, in particular in Africa, tend to be high in relation to productivity. This raises the cost of industrial production.

(4) Management costs. The industry in developing countries often rely heavily on expatriate management and technicians, less so in Latin America than in the other parts of the developing world. Such managers and technicians easily cost 2 or 3 times as much as in their home countries again adding significant amounts to relative costs of production.

(5) Capital and infrastructure costs. Due to higher transportation costs, risks and construction delays, industrial projects in developing countries typically require investment costs that are as much as 25 per cent higher than in developed countries.[10/]

Although not all developing countries are equally affected by the above considerations, they affect to a greater or lesser degree the options for increased production of agricultural machinery open to most of these countries. These options include:

(1) Import substitution. This can be a sound policy, in particular for the manufacture of relatively simple industrial goods where economies of scale are not very important. However, in the production of more mechanized equipment such as advanced tractors or harvestors there are considerable scale-problems.

10/ Ibid., p.93.

(2) Assembly. This offers an often used option to overcome problems associated with small markets and low labour and management skills. Tractors in particular are successfully assembled in many developing countries. Assembly offers an opportunity to gradually increase the local content in the production.

(3) Regional integration. Production for a regional market through some form of economic integration allows manufactuirng in larger series of more diversified equipment. Multi-purpose production is further facilitated. However, certain obstacles are associated with transportation cost, differing levels of development among the integrated markets, inefficient industries that eventually become a burden, and actual or potential political disputes.

(4) Manufacturing for exports. This option is attractive for the newly industrialized countries and the examples of several Latin American producers show that the strategy is feasible provided the factors mentioned above that contribute to relatively high production costs, can be effectively countered. Nonetheless, it must be realized that for most developing countries, producing for the domestic market will in the beginning be the most realistic target.

(5) Integrated approach to manufacturing. Promotion of indigeneous entrepreneurship and the building up of technological tradition is essential.[11/] And the opportunities in this respect are exceptionally good in the manufacturing of simple agricultural tools and implements. This can begin literally in rural blacksmith and small engineering workshops. This would improve agricultural production through the availability of appropriate agricultural implements and machinery and it would also provide an alternative source of income for the rural population. In this way, industrial and agricultural expansion can interact to boost both sectors simultaneously.

Regardless of which option for industrialization and mechanization of agriculture in the developing countries that is adopted, the common urban bias in price policies must be tackled. If the local farmer cannot sell his

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11/ This has been treated extensively in UNIDO/IS.377 op.cit.

production he will not be buying further machinery and hence such will not be produced either. This is not to deny in any way the fact that abundant experience worldwide certainly shows that the political risks of raising food prices can hardly be ignored. Furthermore, the concerns over the impact of such higher prices on real incomes and the nutritional well-being of the poor are genuine and very legitimate. Nonetheless, the agricultural pricing and distribution policies described above have hampered the growth of agricultural production in the developing countries and have thereby been self defeating.

Finally, the drive to increase the mechanization of agriculture in the developing countries must be accompanied by commensurable improvement in road infrastructure, marketing and input distribution, and transport equipment, including such simple means as animal drawn carts or small trucks (pick-ups). It is perhaps because of a lack of such coordinated rural development that the experience with ambitious tractorization schemes in some parts of the world has been, on balance, adverse.

2. Global Production and Trade

2.1 Production overview

Reliable production statistics are difficult to obtain and are often very fragmentary. Data in value terms are only available for the developed market economies, and for Brazil and Mexico. Production for the centrally planned economies and for most developing countries are only available in terms of units. The data in this section exclude handtools and fixed farming equipment due to lack of suitable information.

The agricultural machinery industry nearly everywhere has experienced a severe recession for the past few years. The decline in sales - and profits, where applicable - generally started in 1980, and was further deepened in 1981 and 1982. Where data are available for the early part of 1983, indications are that a recovery is gradually on the way.

In 1980, sales of agricultural machinery products in the developed market economies were estimated at $30 billion in current values or $20 billion at constant 1975 prices. Having been nearly $23 billion in 1975[12/], this represents a substantial decline in real terms. In the producer countries for which post-1980 data are available, sales declined further in 1981 and 1982 (see Table 1[13/]). The production of tractors in the centrally planned economies of Eastern Europe, in terms of units, increased steadily up to 1978 whereafter it has declined. The trend is similar for tractor drawn ploughs although the turning point came already around 1975. In contrast, the production of seeders, harvesters, and combines seem to have reached a plateau by 1981-1982.

Among the developing regions, Latin America is by far the most important one as far as production and assembly of agricultural machinery is concerned.

12/ First Global Study of the Capital Goods Industry: Strategies for Development, UNIDO/ID/WG. 342/3, p. 65.

13/ All numbered tables refer to those in the separate Statistical Compendium on Agricultural Machinery, UNIDO/IS.408/Add.1, Sept. 1983.

There, also, the global trend is evident. From 1960 to 1976, the production grew at a very fast rate but by 1982 it had fallen to levels only one half of those attained in 1976.[14/] As far as can be determined, the situation is similar in the developing countries of Asia and Africa. Overall production has probably fallen since 1977 or 1978 due to declining farmers' incomes, and persistent foreign exchange problems in many countries.

The world's agricultural machinery industry is heavily concentrated in the hands of relatively few producers, which are often transnational. The combined sales of 11 major manufacturers typically comprise some 70 per cent of total sales in the developed market economies. Among these 11 corporations, seven are based in the US, one each in Canada, Federal Republic of Germany, Italy, and Japan. And amongst these, three North American producers (John Deere, International Harvester, and Massey-Ferguson) account for nearly one third of all the developed market economies' sales.

The largest producer countries are the US, the USSR, and Japan. Amongst the OECD countries, the US and the EEC countries as a group each produce some 40 per cent (see Figure 1). Overall, the largest producer countries among the centrally planned economies are Romania and Poland, in addition to the USSR. But, due to planned specialization, the ranking varies by product group. Thus, Bulgaria is big on tractor-operated seeders and ensilage combines, and Czechoslovakia on tractors. The principal producers in the developing countries are Brazil, Argentina, India, Republic of Korea, and China.

The types of machinery produced varies from one country to another. Only the countries with very large domestic markets, such as the US and the USSR, or with fairly isolated but sizable markets, such as Australia, tend to produce a wide range of agricultural machinery. The structure of

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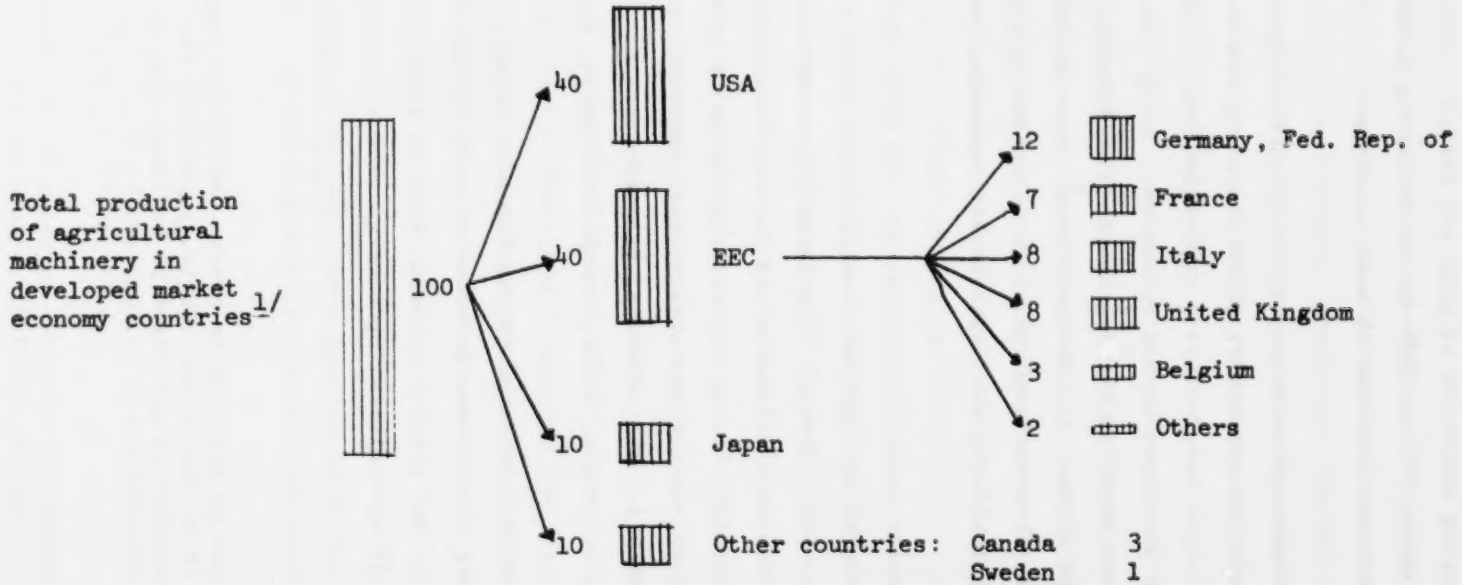
14/ The production of tractors in Mexico, which has begun only relatively recently, is an exception: there, production has been growing although the 1982 production is estimated to be lower than in 1980.

Figure 1: Production of Agricultural Machinery in Developed Market Economies in 1980
(Percentage Distribution)



1/ US $ million 30,000

Source: The Engineering Industries in OECD member countries, basic statistics, 1976 - 1978, OECD, Paris 1982 and UNIDO estimates.

production in a given country can be explained by various factors:

(a) the domestic agricultural productive system determines the type of machinery required,

(b) the demand for given types of machinery on accessible export markets afford possibilities to attain economies of scale in the domestic production, and

(c) the general stage of development: thus, the primary importance of the manufacture of tractors in the developing countries results from the weakness of the capital goods industry in producing a variety of machinery, lack in basic facilities, infrastructure, the versatility of the tractor as a 'general' agricultural machine, social symbolism of the tractor, etc.

In terms of value, as well as number of units, the most important products are the tractors. They represent about 40 per cent of total agricultural machinery sales. Harvesting and threshing machinery constitute the second most important product group with 25 per cent of total sales (see Table 2).

In 1980, world production of tractors of more than 10 HP amounted to over 2.1 million units (see Table 3). However, the maximum level of production in the past 10 years was reached in 1979, when the output of tractors was nearly 2.3 million units. In the first 5 years of the decade between 1971 and 1980, the annual average growth rate of tractors produced was much higher than in the later years when the level of production flattened out.

The world's largest producer of tractors is the USSR with an output of over half a million in 1980, thus providing over one quarter of total world's output. The planned economy countries as a group supply about 35 per cent of the world total. The US was the second largest producer of tractors in 1980 with an output of over 350,000 units. Japan was the third largest producer in 1980 (227,900 units). Japan had a peak in production in 1976 (almost 310,000 units). Beginning with 1972 Japan experienced an extremely rapid expansion. The number of tractors produced increased 3.6 times between 1971 and 1975.

Figures for China are only available from 1977 onwards. In 1980, tractor production slowed down (97,700 units) after it peaked in 1979 (125,600 units), but still occupies the fourth rank in world production.

The four EEC members France, Italy, Federal Republic of Germany and United Kingdom together account for over 20 per cent of total world production. The contribution of the developing countries (excluding China) to the world tractor production is estimated at about 175,000 units in 1980 or about 10 per cent and thus rather limited (Tables 3 and 4). No overall information is available on the extent to which tractors are only assembled or actually manufactured in the developing countries.

Other main types of agricultural machinery products include harvester-threshers, seeders and ploughs (see Tables 5, 6 and 7). Data on these products are of limited reliability since it is much more difficult-especially in the developing countries - to identify tractor or animal drawn and hand-operated machinery than tractors. However, some relationships between the number of units produced of the various types can be deduced (see Table 8). In 1980, for 10 tractors of 10 HP and over, the industry produced 3.7 tractors of less than 10 HP, 1.4 combine-harvesters, 5.3 ploughs and 4.8 seeders. These relationships have not changed significantly since 1971 and the slowdown in the agricultural machinery industry has affected all product groups, except for tractors with less than 10 HP.

The annual average growth of the number of the machines and equipment produced was much higher in the period 1971-1975 than in 1975-1980. Specially combine harvester-threshers, harrows and seeders and planters showed high growth rates from 1971 to 1975. Since then, the annual growth rates have remained positive only for tractors and harrows.

It is estimated that over 50 per cent of all farmers in the developing countries use only hand tools in their work, some of them as simple as wooden sticks to work the soil.[15/] Approximately 90 per cent make their own tools adapting them to tradition and local farming needs. Only limited specialization and trade in these products occur.

15/ UNIDO/ID/WG. 342/3 op.cit. p. 67.

In countries with important export crops such as coffee, tea, cocoa, groundnuts etc., a significant amount of machinery for cultivation and harvesting is produced domestically in medium sized enterprises (10-50 employees).

2.2 Trade

2.2.1 Evolution of international trade 1971-1980

Globally, trade grew in real terms very fast between 1971 and 1975, at 14.7 per cent annually, but since then the growth rate has decreased to only 1.5 per cent per annum, thus parallelling, although lagging, the decline in production (see Tables 9 and 10).

Regionwise, the developed market economies' share in the global trade has declined somewhat, the U.K. accounting for the largest relative drop in exports while both Italy and Japan significantly increased their relative export shares. The centrally planned economies more or less maintained their share in global trade with the gains of the USSR making up for the losses of exports from the Democratic Republic of Germany and the imports to Czechoslowakia. Relatively, the developing countries have increased their share in global exports the most, but absolutely the amounts are still modest. Imports have remained high in both relative and absolute terms although they declined towards the end of the decade.

2.2.2 The world situation in 1980 and developments in 1981

The global picture

World trade in agricultural machinery products[16/] was about US$ 14.4 billion in 1980 at current prices. Based on production data, it can be deduced that approximately one third of the total world production of

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16/ See footnote 2 above for definition in SITC terms.

agricultural machinery is internationally traded. The developed regions dominate the trade between developed and developing regions, (see Table 11). Of total world exports, 77 per cent originated from the developed market economies; five countries alone exported two thirds of this total, namely the US, which is the leading exporting country (21 per cent of world total), F.R. Germany, U.K., Italy and Japan. As a group, the EEC member countries accounted for 40 per cent of the world volume exported both outside and within the community.

All the above mentioned countries have a considerable export surplus in their trade in agricultural machinery. Among the leading exporting nations, Japan has the smallest imports in relation to exports. Therefore, it shows the most favourable export/import ratio, i.e. 5.83 as compared to US which, among the leading exporters, shows the least favourable export/import ratio, namely 2.58.

The centrally planned economies exported more than 20 per cent of the world total. Their exports exceeded their imports only slightly by 3 per cent. The leading 3 exporting countries, namely the USSR (8.5 per cent of world total), Democratic Republic of Germany (5.2 per cent) and Czechoslowakia (2.6 per cent) contributed almost 80 per cent of the centrally planned economies's exports.

The developing countries show a completely reverse picture. They exported only approximately 2 per cent of the world total in 1980; by contrast, they purchased one quarter of the world imports, thereby constituting a considerable market for the producers in the developed countries. They are the leading importing group and ahead of the EEC (21 per cent of world total).

For the developing regions as a whole, its coverage of imports by exports is only .076. When disaggregating the developing region into 3 sub-regions, the export/import ratio for Latin America is .170, for Asia it is .029 and for Africa it is almost nil or 0.001. This unbalanced situation, which is of

course also reflected in the trade in engineering products as a whole, aggravates the adverse balance of payments situation of most of these developing countries.

The developed market economies - trade in 1981

The 1981 export performance of the developed market economies as a group, compared to 1980, indicate a slowing down in the growth of their exports, i.e. exports decreased by 5.0 per cent in real terms (see Table 12). This decreasing trend is more marked in the EEC countries where exports went down by 14.7 per cent. The only two countries that registered a growth in exports were the US and Japan, the largest and fourth largest exporters, respectively.

The developed market economies also reduced their imports in 1981 quite substantially as compared to 1980. In 1981 they imported nearly 20 per cent less in real terms than in 1980 (see Table 13). This drop is sharper in the EEC countries, which imported on the average more than one quarter less than in 1980. Only Canada increased its imports.

Developing economies - trade by regions in 1980

In 1980, the exports of 13 selected developing countries totalled nearly US$ 163 million at constant 1975 prices representing almost 99 per cent of all developing countries' exports. The major exporters among these 13 countries belong to the group of newly industrializing countries (see Table 14).

Brazil is by far the leading exporting country accounting for about one third of total developing countries' exports. Argentina and Mexico come next in importance.

In 1980, approximately 80 per cent of the developing countries' exports went to other developing countries. The majority of this was intra-regional trade from Brazil to other Latin American countries. The remaining 20 per cent were exported to the developed market economies. No exports to the centrally planned economies were registered.

The breakdown of the developing countries' exports in 1980 was as follows:

- Latin America accounted for 88 per cent of total developing countries' exports of which 85 per cent came from Brazil alone, followed by Argentina, Mexico, Colombia and El Salvador;
- Asia's share in developing countries' exports was about 11 per cent. Singapore exported about one third of all Asian developing countries from output produced in off-shore plants;
- Africa's exports are almost negligible with less than one per cent of total developing countries' exports.

By 1981, the situation had not changed structurally, at least for the countries for which data are available (see Table 15). Notably, however, Brazil had managed to increase its exports to other developing countries.

On the import side the country concentration is less marked than on the export side. In 1980, the 23 major importing countries accounted for about 65 per cent of total developing countries' imports (see Table 16). In 1980, more than 85 per cent of the purchases of the developing countries came from the developed market economies, 11 per cent from the centrally planned economies and only 4 per cent from the developing economies. Thus, with the exception of three Latin American countries, namely Argentina, Colombia and Venezuela, where inter-regional trade is of some significance, world imports from developing countries are almost nil.

In 1980, the distribution of imports by developing regions was topped by Asia (40 per cent), followed by Latin America (38 per cent). Africa accounted for 22 per cent of total developing countries purchases.

In 1980, Brazil was the only net exporter of agricultural machinery among the developing countries. This situation seems to have continued in 1981 judged by the available 1981 trade figures. Selected major countries for which data are available show a more or less unchanged situation in 1981 (see Tables 16 and 17). Significantly, this seems to indicate that no major slump in the trading performance of the developing countries occurred in 1981 as compared to 1980.

Trade by groups of products

At the global level, trade in agricultural tractors was and remains the most important single trading item, accounting for over half of the total trade in agricultural machinery (see Table 18). Machinery for cultivating and harvesting comes second in the international trading list, amounting to 40 per cent of world exports in 1980. Both groups showed a slight increase of their share of total agricultural machinery trade between 1971 and 1980. Throughout the seventies, the export destination distribution has remained fairly stable although the share going to the developing countries was slightly higher in 1975 than at either the beginning, or the end of the decade (see Table 19).

The dominating position of tractors in the international agricultural machinery trade shows the importance which is given to tractorization in the development of the agriculture sector. This fact becomes even more clearly in when considering that tractor imports account on the average for over 60 per cent of total agricultural machinery imports by developing countries (see Table 20). In Africa they account for even more than 70 per cent.

2.3 Present and foreseeable trends in the mechanization of agriculture

2.3.1 A qualitative assessment

Since the 1950ies, mechanization of agriculture has made rapid progress everywhere, except for large areas of Africa where the typical smallholder still uses primarily simple hand tools and only occasionally animal drawn implements. The trends towards increased mechanization is illustrated as far as industrialized countries are concerned by the increasing numbers of tractors per unit of agricultural land in the ECE region (see Table 21). At the same time, average horse power per tractor also has increased steadily so that tractor horse power per unit of agriculture land went up even more quickly than the number of tractors.[17/] These developments have, in

17/ "European Agriculture - A Very Old But Rapidly Changing Branch of the National Economies", Economic Bulletin for Europe, vol. 35, No. 2, pa. 159.

general, brought about an increased flexibility in operations and facilitated the execution of combined operations. The trend towards more machines and higher horse power per unit of land is expected to continue although at a slower rate than in the period 1960-1975.

Apart from tractors, many other types of agricultural machinery have been developed and introduced in the past two or three decades. Of great importance are the fully mechanized harvestors-treshers with their positive contribution to quality and low losses. The latest development in mechanization, now being implemented on the North American and European markets, is the application of microprocessors to many of the mechanized operations in agriculture. Primarily, these allow for greater efficiency in cultivating the soil, sowing and planting, applying of fertilizers and pesticides, harvesting, and usage of fuel. The importance of this development will increase as the cost of such inputs as seeds, fertilizers, labour and fuel increase. The absolute decline in the agricultural labour force (see Table 22) will also continue to exert pressure on increasing efficiency.

Finally, environmental considerations will emerge to require increased precision in tilling the soil and applying chemical inputs.

Taking rising yields per unit of land as an indicator of technical progress, it can be said that the mechanization of agriculture has led to very significant increases in productivity (see Table 23 for data for industrialized countries). Consequently, agricultural production has risen faster than total population in the developed countries and in many places lead to over-production. In most developing countries, however, the population growth has outstripped the gains in agricultural productivity leading to decreasing food supplies per capita. Although equilibrium could technically be achieved by continuing to over-produce in the developed countries and shipping the surplus to the deficiency countries, this is not generally seen as the long term solution. Rather, the population growth in the developing countries must slow down and the productivity of agriculture must be increased (especially since the agricultural land area cannot be much expanded without further ecological consequences such as disappearing

forest cover).[18] This will entail an increasing demand for agricultural machinery in the developing countries. In the developed countries, especially in the market economies, the demand will increasingly take the form of replacement demand with an accent on higher efficiencies and safety and confort of the operators rather than more machines or greater power.

A considerable growth in capital invested per unit of labour can be observed in all countries for which data are available (see Table 24). Nonetheless, there are pronounced differences in the investment levels achieved and in some countries saturation levels may have been approached by the early 1980ies.[19] But, as always, the question of optimal ratios of capital to other inputs must be seen in relation to the opportunity cost of capital and its marginal productivity in other sectors of the national economies. In some instances, productivity in agriculture may be increased more and more cheaply by irrigation, application of proper technique, pest and drought resistant seeds and plants, and weedkillers such as paraquat that hold out a promise of no-tillage cultivation, and improved crop storage facilities.

The technical requirements for agricultural machines in the coming years can be summarized as follows:[20]

- more capacity per unit in countries with large farms (in particular the US and the centrally planned economies);
- small, flexible and inexpensive machines for small farms;
- increased reliability and less maintenance;
- less damages and losses resulting from use of machinery;

18/ See discussion in First Worldwide Study of the Wood and Wood Processing Industries, UNIDO/IS.398, Aug. 1983.

19/ ibid., p. 163.

20/ Much of the remainder of section 2.3.1 is based on document FAO/ECE/AGRI/WP.2/46, prepared in 1981 by the FAO/ECE Working Party on Mechanization of Agriculture, as reported in Economic Bulletin for Europe, Vol. 35, No. 2, pp. 213-222.

- special equipment for slopes and heavy or sandy soils;
- increased use of equipment suited for reduced tillage and non-tillage farming practices;
- improved transmissions and hydraulics to match engine and ground speeds to load;
- increased use of front wheel or four wheel drive to reduce tire slip and power loss, and to improve fuel economy;
- electronic or microprocessor controlled devices and sensors to permit more accurate control over implement precision;
- more comfort and safety for the operators;
- better machines for harvesting and handling of vulnerable crops;
- more standardization in components; and
- more attention to environmental damage.

The past trend towards larger agricultural machines seems to have slowed down in many countries, e.g. the US. The difficulty of transportation from one field to another, the limitations of the farm size and lay-out as well as other economic considerations (indivisibility of inputs) are setting limits in this respect. Instead, other possibilities for capacity increase, like higher working speed and a combination of several operations in one machine, are probed.

Where the agricultural production is too small to justify the use of a (large) machine, individual farmers will find proper forms for multi-farm machinery use provided they will find a profitable market for the resulting increased production. This development will result in a demand for larger and more sophisticated machinery than otherwise would be the case.

Human labour as a source of power in most agriculture of commercial importance is rapidly vanishing. Similarly, the use of draught animals, although still important in many regions of the developing countries, is being replaced by motor power. The expectation is that the growth in available power per hectare will slow down in the presently already highly motorized regions but in others it will continue with the same or even higher speed as in the past decade. Tractors will remain the most important power source but there will be a shift towards self-propelled machines and stationary electric

motors on the farm. Of course, the latter development is closely conncected to the progress in rural electicification.

The size of tractors, and other machinery, directly depends on the size of the farms. Thus, the machines are small in most developing countries but also in such industrialized countries as Switzerland, the Netherlands and even the Federal Republic of Germany whereas they are large in the US and Canada, the USSR and Hungary. In countries with a high tractor density, the total number of tractors will decline due to the diminishing number of small farms and increased power per tractor. Presently, the most common agricultural tractor on middle sized farms has a power between 40 to 80 HP. In many countries, there is a striking number of makes and types which causes problems with the supply of spare parts and maintenance. Thus, there are concerted attempts to reduce the variety of tractors on any given market and to standardize certain parts such as transmissions and tires.

The characteristics of tractors are expected to change in the following direction:

- more hydraulic and hydromechanical drives;
- transmissions enabling gear change on the go;
- new hydraulic systems with higher pressures;
- position and power regulation of coupled machines;
- on-board microprocessors for selecting optimum operations modes;
- automatic hitching devices for trailers and farm machinery;
- better working conditions for tractor operators;
- more front wheel and four wheel drives;
- increased reliability and durability;
- reduced daily maintenance requirements; and
- reduced specific fuel consumption.

Diesel oil will remain the main fuel for agricultural tractors for both economic and technological reasons. Use of alternative fuels (gas or gasohol) will be marginal and mainly only in cases of scarcitiy.

Mechanization of crop farming

Mechanization of almost all operations in crop farming is possible although no truly satisfactory solution has yet been found for the harvesting of some vegetable and perishable crops. No doubt, however, such solutions are forthcoming and then the distinction between arable crops and horticultural crops will disappear and the latter ones will be grown on a bigger scale with less need for manual labour. This will have obvious implications for the amount of agricultural machinery in demand. Where necessary, the capacity of the machinery (for soil loosening, for example) will be increased and self-propelled machines will gradually substitute tractor - machine combinations.

The size of ploughs and other implements will have to be adjusted to the gradually increasing size of tractors. Where the erosion of the top soil is severe, or threatens to become severe, emphasis on reduced tillage or no-tillage methods will receive priority. The necessity of reducing the number of passages on the field will promote the combination of several operations in one pass, i.e. by one machine. On heavy soils, sowing and planting machines can be combined with power harrows and on light soils with harrows using crumble rollers. Fertilization and application of herbicides and pesticides can also be included in combined operations.

No significant technological change in the existing design of drills and planters for arable crops are expected. However, they will become wider and can be equipped with electronic gear for regularity control. Sowing and planting machines will increasingly be combined with machines for soil tillage, fertilizing and crop protection. The introduction of more expensive hybrid plants and seeds may increase the demand for precision drills, especially in horticulture.

When spreading fertilizers in large quantities, there is a trend back towards more exact spreaders. These give higher yields and more even maturity with lesser amounts of fertilizers. The risk of leaching into the ground water is also minimized.

The use of organic manure instead of chemical fertilizers is expected to increase again. However, this will require the use of special vehicles for transport of liquid manure over fairly long distances. These transporters have special tires and wheel systems to enable driving on soft soils as well as on hard roads. New varieties of crops may in the future require less chemical protection and therefore also contribute to a possible reduction in the demand for fertilizer application equipment. The design of such equipment will take into account the working conditions of the machine operator during spraying.

Radically new harvesting machines can only be expected for fruit, berries and vegetables. Otherwise harvesting machines will only get bigger and better; they will require less and easier maintenance and repair, and the resulting quality of work will improve (less losses and damages). The increasing size of the machines will cause self-propelled machines to replace the trailed type unless larger tractors are used which have sufficient power to drive the combine harvesters without an assisting engine.

Combine - harvesters will undoubtedly do most commercial harvesting of grain, except for rice. On fields which are not suited for these machines, other crops will be grown. Harvesting of crop by-products will increase because the material will be important as fuel or as raw material for biotechnology.

Environment

The damage of modern agriculture to the environment will be controlled by technical means:

- noise from engines, ventilators, etc. will be prevented and dampened, and
- application techniques for fertilizers and pesticides will be improved to reduce the risk for water and soil pollution.

Energy

Increased tractorization and mechanization in general of the agricultural sector in developing countries may lead to a sharp increase of national consumption of petroleum products. For many developing countries which do not possess indigenous oil resources this would impose an additional pressure on the balance of payments situation and affect the industrialization process which also needs increasing supplies of petroleum products.

Although it is difficult to present specific figures for the current use of petroleum products by agricultural machinery in developing countries and corresponding predictions for the future, it is possible to give some order of magnitude informalities on the present situation. Thus, a five-fold increase in commercial energy use in crop and livestock production for 90 developing countries accounting for 97 per cent of population of the developing world outside China is predicted for the year 2000 (see Table 25). It should also be noted that the share in the energy use of farm machinery is expected to rise from 31 to 37 per cent.

Petroleum products are the most widely used source of commercial energy for agricultural machinery, therefore it is necessary to consider what could be done to avoid possible problems connected with meeting the petroleum requirements of a growing agricultural sector in developing countries. One possible solution that could become the most acceptable for developing countries and that attracts a lot of attention in many developed countries as well is ethanol from biomass. The production of fuel ethanol by fermentation has a long history but the availability of cheap oil during the 1950ies and 1960ies caused a decrease in interest in this source of energy. But the increase in the price of oil in the 1970ies made ethanol again attractive as an alternative type of fuel.

It should be noted that the possibility of ethanol production from biomass particularly from agricultural products and residues as well as production of energy from biomass in general raises the question of how such developments would affect production of food. This problem requires a thorough investigation and techno-economic feasibility studies for concrete cases.

At the same time there are technical problems connected with the substitution of petroleum based fuels for agricultural machines by fuels derived from biomass. Whereas existing automobile engines do not require any modifications to run on gasohol which is an alcohol/gasoline mixture of 20 per cent ethanol fluid, the case is different for diesel engines which are the main type of engine used in agricultural machinery. Straight ethanol is unsuitable as fuel in diesel because of its high flamability and inability to combust uniformly. According to the World Bank Study,[21/] Brazilian automobile industry and government institutes report that mixtures of various vegetables oils and ethanol(with or without gasoline blends) can be used as fuel in diesel engines. However, it is pointed out that though it is possible to identify technically satisfactory solutions in the near future, considerable doubts remain whether ethanol can economically replace diesel fuel in the immediate future, since most preliminary test results indicate specific ethanol consumption of between 1.6 - 1.8 times that of diesel.

Conclusion

The trend toward increased mechanization in agriculture will still be predominant in regions when the mechanization level is low. This will be done by applying present technologies at a wider scale. The further development in already highly mechanized areas will be characterized by increased automation and microprocessor control of operations, improved working conditions for operators, and more attention to environmental protection, and the quality of agricultural products.

Research, extension and education in agricultural engineering will be required continuously to keep up with changing circumstances both within and outside the agriculture sector.

Increased tractorization and mechanization of developing countries will result in a further increase in their use of commercial energy.

21/ Alcohol production from biomass in the developing countries, World Bank, September 1980, p.8.

2.3.2 Projected apparent consumption of agricultural machinery, 1990 and 2000

In order to obtain a quantitative assessment of the future consumption of agricultural machinery in the world, simple econometric models of apparent consumption have been estimated for those UNITAD regions[22/] for which reasonably complete time series data were available. The models are specified in equations expressing a hypothesized relationship between apparent consumption of agricultural machinery and a given set of determining variables, as follows:

Dependent variable: Apparent consumption of agricultural machinery production (Production + Imports - Exports)

Explanatory variables:
- Gross domestic product (GDP)
- Gross output[23/] ISIC 311 + ISIC 313 + ISIC 314
- Gross capital formation
- Tractors in use
- Harvesters in use
- Arable land

As estimated models, the equations represent only empirical relationships between apparent consumption and the explanatory variables. Thus, the estimated regression coefficients cannot be given strict economic interpretations[24/].

22/ For further reference see The UNITAD System, 1981 Report, UNIDO/IS.337, September 1982.

23/ ISIC 311 Food manufacturing
313 Beverage industries
314 Tobacco manufacturers

24/ The estimated coefficients are biased and have unduly large standard errors because of significant multicollinearity in the data. But the joint distribution of the coefficients in all the estimated models is tight and the coefficient of multiple determination (R^2) is without exception very high. Those are important characteristics of any forecasting model and, as long as the past multicollinearity in the data can be expected to continue, the possible "wrong" signs of the estimated coefficients and their large standard errors have little consequence for forecasting. Of course, the influence on the forecasts of individual variables cannot be determined without reference to the multi-correlated structure.

The absolute level of mechanization in agriculture is thought to exhibit an S-shaped form with respect to the main determining variables. That is, the level increases first at an increasing rate, thus slowing down to a constant rate (the inflection point) and finally decreasing to approach a fixed saturation level. Most countries and regions are still thought to be at the increasing rate portion of the curve (to the left of the inflection point); only North America is likely to be experiencing a decreasing rate of increase (to the right of the inflection point). The simplest functional form to handle both situations is the double log specification which is then chosen for all the regional models.

The regions correspond to those of the UNITAD model but because of lacking data do not always contain all the countries of the UNITAD regions. The use of the UNITAD model promotes consistency in the work of UNIDO in two ways: (1) the regional coverage for any two industrial sectors is always the same, and (2) the assumptions regarding future values for main determining variables such as GDP are the same for all sectors. For a balanced industrial strategy for any country or region, such consistency among sectors and studies is more important than absolute precision in individual assumptions or forecasts of future values.

Because of non-existent data, the models could be estimated only for a few regions, mainly those comprising the developed market economies[25/] and Latin America. Even then, great difficulties were experienced because of periodically lacking data for some countries and/or some years and a great deal of efforts had to be expanded to either locate or estimate the missing data. The resulting data base is now unique in its coverage and will therefore be fully presented--together with a detailed version of the model--in a separate document for further use by researchers in this field. However, the limited coverage of developing countries obviously reduces the applicability of the results. It is hoped that the coverage can be expanded in the future.

25/ The projections for Japan may be unduly high because of overly optimistic growth rates predicted for its GDP; they are therefore not presented for the time being.

Two alternative projections are presented. The first one is based on the full econometric formulations and assumptions concerning the future values of gross national product and gross fixed capital formation supplied by the Global and Conceptual Studies Branch of UNIDO's Industrial Studies Division and FAO predictions for arable land and number of tractors and harvesters. These forecasts are to be considered preferred over the second alternatives which are simple trend extrapolations of past apparent consumption in relation to time.

Both projections show an increase in consumption between 1980 and 2000 with the exception that the econometric model indicates an initial decrease for North-West Europe (see Table 26). Generally the trend extrapolation model gives much higher projected values. Non-linear trend extrapolations again would yield very unrealistic (unbelievable) results: for example, Latin America would exhibit drastic reductions in its apparent consumption of agricultural machinery.

The linear model shows decreasing rates of growth in all regions. The econometric model predicts an inital drop in apparent consumption from 1980 to 1990 for Norther West Europe and thereafter a stabilization.[26/] Otherwise, this model shows decreasing growth rates, too. These results indicate clearly that although the apparent consumption of agricultural machinery can be expected to increase strongly all over the world, the saturation process will reduce future growth rates especially in the more developed regions. Although the centrally planned economies and developing countries as a whole are not included in the model, we are safe to assume strong increases in the consumption of these regions.

The total consumption for all regions--excluding Japan--according to the econometric model shows annual growth rates of 1.2 per cent between 1980 and 1990 and 2.1 per cent between 1990 and 2000. The linear extrapolations yield aggregate growth rates of 3.3 per cent between 1980 and 1990, and 1.7 per cent from 1990 to the end of the century.

26/ The reduction in Western Europe can also be expected when the current overproduction in agriculture in many of the countries is brought under control.

Although mainly of indicative value, the above projections show clearly that the main markets for the industry will continue to be developed regions. This in its turn indicates that the problems of developing countries, having either a comparatively weak industry or importing ill-adapted machinery from other regions, will largely remain unchanged in the coming decades unless specific measures are taken to rectify the situation.

The estimations referred to above inso far consistent with the FAO projections of the use of agricultural machinery,[27/] as FAO data are used as explanatory variables in the UNIDO projections for the developing countries for the years 1990 and 2000. The objective of FAO scenarios was to identify issues, quantify and analyze them to the extent possible and then suggest policies for encouraging an adequate contribution of the agricultural sector to overall development. The above projections are more modest in scope. However, compared with the FAO data the UNIDO projection gives the following additional information:

- It attempts to cover the whole world and not only developing regions. The coverage of developing countries, however, is low.

- It gives apparent consumption in constant dollar values of 1975 whereas the FAO data give the use of various types of equipment in units.

- The concept of apparent consumption takes into account both domestic production and foreign trade. Improved projections will therefore allow analytical statements on these variables.

- The projection constitutes a link between the FAO forecasts and the global UNIDO projections for manufacturing industry and the economy as a whole.

27/ FAO, Agriculture Towards 2000, Rome 1979.

3. Regional Summaries[28/]

3.1 Developed market economies[29/]

3.1.1 An overview of the agricultural machinery sector

The agricultural machinery sector is characterized by a handful of multinational firms producing a range of tractors and implements, and by a multitude of smaller, more specialized firms. John Deere, International Harvester, and Massey-Ferguson account for some 30 per cent of total world output. Of total sales volume, Massey-Ferguson and John Deere derive 90 and 80 per cent, respectively, from the sale of agricultural machinery, whereas Ford is only 5 per cent product specialized. The North American manufacturers produce primarily for the domestic market although the transnational nature of most of the larger companies creates a significant amount of corporate interrelationships between manufacturing and marketing in a multitude of countries. (See Table 33).

The largest firms, Allis - Chalmers, J.I. Case, John Deere, Ford Motor Company, International Harvester, and Massey-Ferguson typically produce machinery in the US, Canada, one or more European countries and one or more large developing countries such as Brazil and Argentina. Several of the large companies also maintain assembly lines in smaller developing countries. However, total sector employment in the US as a percentage of the

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28/ The following are summaries of regional surveys of the world agricultural machinery industry, carried out for this study. The Latin America Survey is simultaneously issued as "A Survey of the Latin America Agricultural Machinery Industry" (UNIDO/IS. 407). The African Survey has been issued as "Agricultural Machinery and Rural Equipment in Africa. A new approach to a growing crisis" (UNIDO/IS. 377)

29/ The information base for this section comes primarily from a consultant report based on agricultural machinery producer's annual reports, US Department of Commerce statistics, and telephone interviews with company representatives and government officials. Much of the information was acquired through communication with manufacturers, associations of and discussions with market analysts. The supporting statistical tables are given in the separate Statistical Compendium, (UNIDO/IS.408. Add.1).

worldwide employment by four major North American producers have steadily increased from 53 per cent in 1978 to 87 per cent in 1982 signalling relative decline in overseas operations.

More than 50 per cent of the European production is manufactured in Germany Fed. Rep. (see Table 36), France (see Table 37), the United Kingdom (see Table 38) and Italy. A significant agricultural machinery industry is also located in Sweden, Spain, Finland, Austria and the Netherlands (see Table 39). However, the production in the latter two countries is mostly comprised of complementary parts that are added to tractors or other basic machines, to suit specific market demands.

The period after World War II, marked by a rapid expansion of the market, did not result in the establishment of Western European heavy machinery industries. The market demands was supplied by firms of U.S. origin. The exception is the Italian company Fiat, which has managed to secure a substantial market share both at home and abroad. Of the Western European market, 14 per cent was controlled by Fiat in 1981.

Only a few of the manufacturers produce a full line of agricultural machinery, the majority typically produce specialized machinery. Some multinationals have specialized in specific lines of the industry and control substantial shares of the market. That is the case for Allis Chalmers and Claas in combine harvesters and the Japanese Kubota in below 40 HP tractors.

With 450 main types of machines, the agricultural machinery industry employs in Western Europe 250,000 people in 4,000 production plants. The industry related labour force that is indirectly mobilized by this market is estimated to amount to 200,000 people. This force is mostly engaged in the retail business and the firms subcontracted for project basis work.

The production of tractors represents more than half of the total agricultural machinery output in Western Europe. The percentage of tractors in 1982 of the total production of agricultural machines was about 53 per cent in Germany Fed. Rep. (See Table 35), 40 per cent in France, 73 per cent in the United Kingdom, and 51 per cent in Italy. In contrast, tractors constitute only about one third of the value of agricultural machinery production in

North America. This is likely due to the larger share of harvesters and combines in the North American production.

Of the total turnover in the industry of agricultural machinery in Western Europe, an estimated 5 per cent is allocated for research and development. The most notable innovations in the technology of this industry are directed towards the improvement of comfort and security, the usage of electronics and the efficiency of production lines.

Japan is emerging as a major producer of agricultural machinery, especially of smaller sized (less than 50 HP) tractors. Today, Japan produces approximately 10 per cent of the total production of agricultural machinery in the developed market economies. In tractors, Japan, USSR and the US are the three largest producer countries in the world.

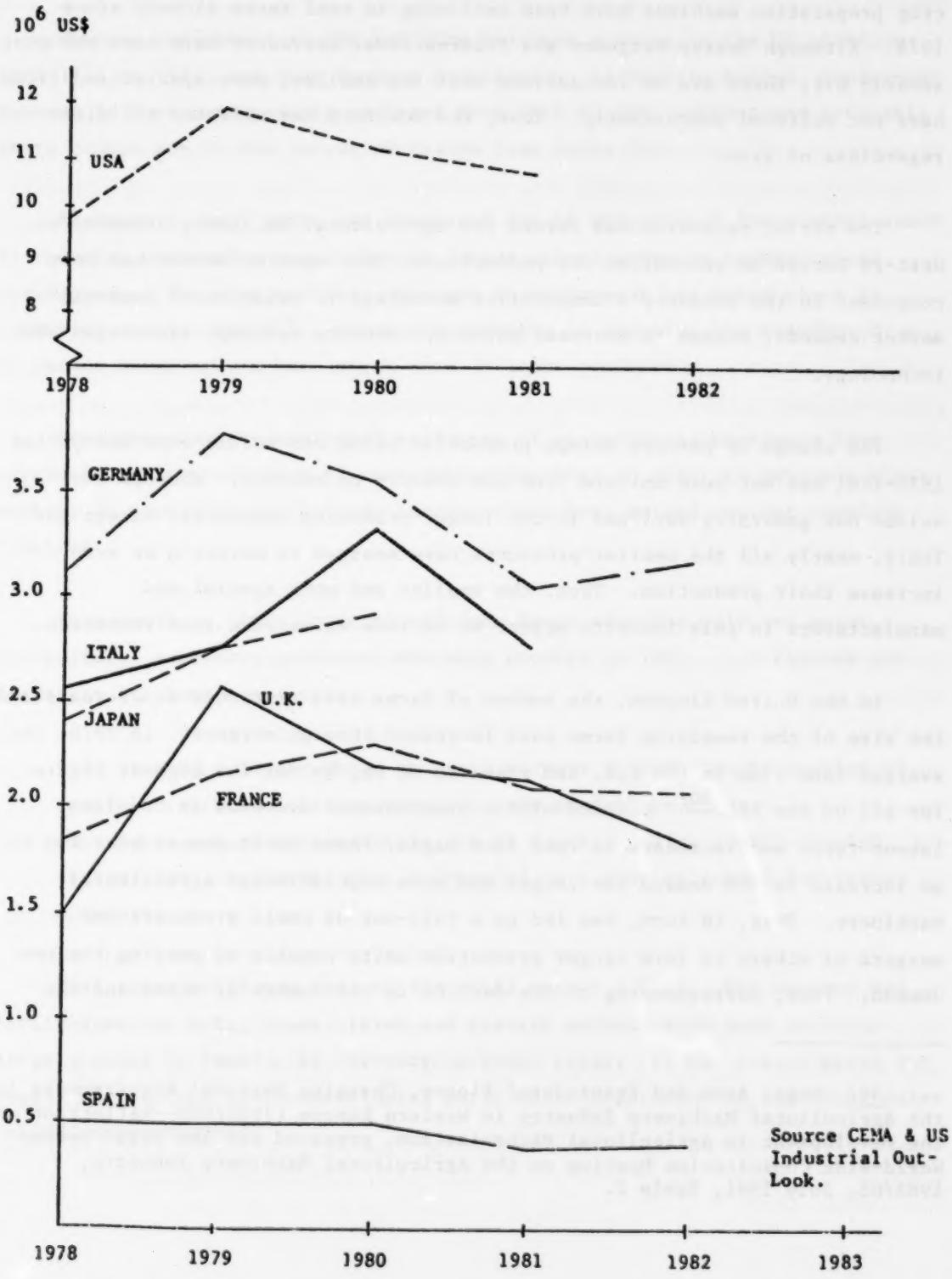
3.1.2. Current production and market situation

Industry sales in North America in real terms peaked in 1979 and were drastically down in 1982 (see Table 27). The industry turned from profitability to losses in 1980, including massive losses for 3 of the major 6 manufacturers. Only John Deere has shown continuing profits due to streamlined operations and a growing domestic demand for large tractors. The industry appears not to be in a financial position to make major investments. However, the prospects for 1983 are now improving.

Dealer inventories have remained steady but manufacturers have been drastically cutting inventories. Employment likewise has been severely curtailed, (see Table 28).

In response to the market situation, many North American manufacturers have been operating their plants at less than full capacity, reduced employment, cut wages, lowered their inventories, and consolidated their operations. Plants have been closed or downsized, and divestments have taken place. The data indicate that the conditions in the sector are fairly homogeneous over

Figure 2
Trends in products of agricultural machinery



Source CEMA & US Industrial Out-Look.

the product categories. Real shipments peaked in 1979 for all categories but haying machinery and irrigation systems peaked a year later and the sales of crop preparation machines have been declining in real terms already since 1978. Although Massey-Ferguson and International Harvester have been the most severly hit, there are no indications that the smaller, more specialized firms have not suffered concordantly. Thus, the downturn has affected all firms regardless of size.

The recent recession has forced the agricultural machinery industry in Western Europe to specialize its production. This specialization has been congruent to the industry's comparative advantage in relation to domestic market demands, access to overseas markets, currency exchange advantages and technology.

The change in Western Europe production value and volume over the period 1976-1981 has not been uniform from one country to another. Whereas the volume has generally declined in the larger producing countries, except for Italy, nearly all the smaller producers have managed to maintain or even increase their production. Thus, the smaller and more specialized manufacturers in this industry appear to be less vulnerable in a recession.

In the United Kingdom, the number of farms have continued to decrease and the size of the remaining farms have increased through mergers. In 1978, the average farm size in the U.K. had risen to 66 ha, by far the highest figure for all of the EEC.[30/] Coupled with a simultaneous decrease in the farm labour force and increases in real farm wages, these developments have led to an increase in the demand for larger and more sophisticated agricultural machinery. This, in turn, has led to a fall-out of small producers and mergers of others to form larger production units capable of meeting the new demand. Thus, corresponding to the decline in the number of farms and the

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30/ Gego, Arno and Franz-Josef Pingen, Changing Regional Requirements in the Agricultural Machinery Industry in Western Europe (1950/80)--Reflection of the Development in Agricultural Mechanization, prepared for the UNIDO Second World-Wide Consultation Meeting on the Agricultural Machinery Industry, 1982/83, July 1981, Table 2.

increase in their size, we have a decrease in the number of firms and expansion in size of the firms producing agricultural machinery (see Table 48).

Whereas employment in the industry had been growing in the US steadily from 1978 to 1981, and then dropped drastically, in Western Europe, employment appears to have continuously declined from 1979 to 1982 without any noticably sharp change due to the recent recession (see Table 34).

Apparently, employment has decreased due to streamlined investments aimed at reducing production costs through labour substitution by technological development. The most critical decrease in employment has taken place in countries such as the U.K., where the industry is adapting its manufacturing to lesser total volume but larger size of units produced.

Some European transnational producers of agricultural machinery have increased their production of unassembled tractors in order to maintain their markets in countries where trade barriers have been raised against complete tractors.

Interestingly, Fiat Trattori and John Deere were the only two major agricultural machinery producers who made profits in 1981. The reasons are different for both companies:

- Fiat secured a larger share in world markets through its production of special tractor models for tropical crop production.
- John Deere was able to maintain its US domestic sales stable through streamlined investments that correspond to a growing demand for larger tractors.

Fiat exported 70 per cent of its total output (1981). The company has infiltrated the U.K., Greek, Irish and Spanish markets with much success, largely aided by beneficial currency exchange terms. It has consolidated its supply of tractors to the developing world where 3 per cent of its total sales in 1981 were absorbed.

Like in so many other industrial sectors, Japan's production of agricultural machinery has shown a spectacular increase since the end of World War II.[31/] The total sector output, in real values, was in 1980 nearly 3 times larger than what it was 15 years earlier. Especially in the beginning, the demand came primarily from the domestic markets when an increase in productivity was badly needed to make up for a conspicious labour shortage in rural areas. Also the type of machinery developed and manufactured in Japan - rice paddy machinery including rice planters and combines - was not in great demand on the export markets. Later, however, the advancement of domestic technology enabled Japan to produce high-performance tillers and tractors, also for export. The major export product is small tractors which account for nearly one half of all exports. However, as far as the North American export market is concerned, it is questionable whether these tractors should be considered agricultural machinery since they are primarily used for homes and estate maintenance and very small (non-commercial) farms, utility work and light industrial applications. But exports of rice culture related machinery to Southeast Asia has been increasing due to rising incomes and increased demand for higher productivity in those countries.

Generally, the developed market economies' imports have followed the developments on the domestic market. In the US, the export market downturn lagged the domestic downturn by 2 years thus coinciding with the dismal domestic market to exacerbate industry problems in 1982 (see Tables 30 and 32). Among tractors, US producers are only competing in the market for large (over 100 HP) tractors. Harvesting machinery exports remained strong in 1980 and 1981. Small Japanese tractors dominate the imports to the US (see Table 29).

Because of the worldwide recession, international trade has languished and protectionist measures have proliferated to protect jobs at home. 1982 was the sixth year of decline in worldwide farm and industrial machine sales.

31/ Much of this section is based on Yoshio Suyuki, "Current Trends in Agricultural Machinery Industry", Industrial Machinery Division, Machinery and Information, Industrial Bureau, MITI, Digest of Japanese Industry and Technology, No. 169, 1982.

In the US, real exports have declined for the past two years, with a drop of more than 5 per cent in 1982. The Common Market supports internal wheat prices--that are as much as 40 per cent higher than US and world market levels and compensates exporters in cash for the differential. The European farm programme outlays for domestic price supports and export subsidiaries could reach US$16 billion this year.[32/] Recessionary erosion of US exports has been exacerbated by the strong dollar. At the same time, the Japanese yen is comparatively weak. The resulting gap has been detrimental to the US based manufacturer or several export markets.

Farm machinery imports to Japan have always been rather small. It consists primarily of large-sized tractors and related implements as well as dry field farming machines and grass weeders developed for rice paddy use. In the future, imports are likely to remain small and consist primarily of large tractors and machines used in dry level farming and cattle raising. Imports might even decrease since domestic production of large tractors is gradually replacing current imports.

3.1.3 The market outlook

The demand for agricultural machinery is a derived demand: it is the demand for an increasingly essential input to the production of agricultural goods and services.[33/] Thus, the demand for farm machinery is highly dependent upon the primary demand for agricultural products. Additional very important variables are farmers' incomes, the available credit terms and most important, government agricultural support programs. Since these variables vary a great deal from country to country, the market outlook varies a great deal in individual countries.

32/ International Business Week, 1983-07-18.

33/ "Services" in the sense that there exist enterprises, farmers' organizations and cooperatives that are in the business of providing such services as tilling, harvesting etc. to independent farmers without own equipment. This is specially true where individual farm sizes are small such as in many parts of Western Europe.

Agricultural machinery is a capital intensive industry. As such it has been particularly hard hit by recent high interest rates. This has affected not only the domestic but also the export markets because interest rates have been high world-wide. Exports of agricultural machinery from the US is further severly hampered by the continuously strong dollar. To hold costs down, US manufacturers have to buy more components from foreign suppliers and shift production from US plants to overseas subsidiaries and licenses.

In North America, continuing low grain prices, substantial reduction in acreage, but uncertain future of still high interest rates despite a burgeoning recovery in the national economies, cause capital outlays for agricultural machinery to remain near the depressed levels of 1982. However, US retail sales of tractors are expected to increase later in 1983 and 1984.

In fact, now the latest information appears to indicate an unexpected upturn in all farm equipment sales.[34/] Paradoxically, behind this development is, in part, the US Department of Agriculture's new Payment-In-Kind (PIK) Programme, which is designed to remove some 23 million of acres from crop production but which has in fact improved many farmers' revenue outlook by guaranteeing quite a bit of income for leaving acres idle. Moreover, there is a lot of pent-up demand due to delayed replacement of farm equipment. The normal replacement cycle for heavy farm equipment is about eight to nine years long. Based upon that, a 'boom' was due in 1980 and 1981, and that has now been delayed.

Rather than expanding farm sizes, the farmers will turn to intensification of farming on present land. Although this will mean heavier fertilization, thicker planting, and more double cropping, it will also entail further increase in the use of agricultural machinery and equipment, especially spraying and irrigation equipment.

34/ The Wall Street Journal, 1983-05-06.

Technological innovation will continue to be important on the North American market. In part, this will protect the domestic producers from imports and maintain their competitiveness in the upper end of the market, even for exports despite the continuing disadvantage of a strong dollar.

In July 1982, the compounded annual rate of growth of US farm machinery industry from 1982 through 1987 was forecasted to be 4 per cent. Exports were expected to grow although at a decreasing rate because US manufacturers do not produce much of the small machinery required by the developing countries. This forecast is now believed to be too optimistic for the near term. The firm orders situation is now improving for all manufacturers with the exception of the Latin American markets where orders are decreasing.35/

North America is one of only a few areas in the world with the ability to supply both domestic demand and substantial exports. At the same time, population growth is outstripping the increases in food production in large areas of the world. One way or another, this is going to lead to continuing large, and perhaps even increasing exports of agricultural products from North America. Thus, for producers of agricultural machinery, this will mean a continuing large market in the long run in North America.

In the United Kingdom, the medium-term outlook is dependent on a sustained improvement in the agricultural commodities market. The first quarter of 1983 has seen a rise in tractor registrations of 15% compared to the same period in 1982. The rise in purchasing appears to be influenced by a continued expectation of falling prices of agricultural machinery. The recession period of 1976 to 1981 has encouraged competitive discounting to which the farmers have got accustomed. A maintained level of demand will be a reflection of farmers expectations, prices and interest rates. The present

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35/ The depressed situation on the Latin American market is as seen by the North American producers. Latin American producers may not concur with this view.

low level of commodity prices is showing improvement. Presently manufacturers are auctionning machinery to deploy stocks and selling at minimal margins. Large scale investment for plant modernization will take effect as credit interest rates moderate.

The Netherlands is a net importer of agricultural machinery, especially tractors. The domestically produced products consists mainly of attachment parts. The market is presently characterised by replacement demand, influenced by an expansion of farm sizes by reduction of units, through a process of mergers, and by replacements of older models by new machinery.

The expansion of farm sizes has been induced by market pressures to lower costs, as a result of increasing labor costs. The effect of this trend has been to increase the mechanization level, calling for machinery of higher horse power. Also, more security and comfort demanded by farm workers are factors influencing replacement. The increasing trend in replacement demand in the Netherlands is expected to maintain itself throughout the medium term.

Demand for agricultural machinery in France faces several difficulties in the short and medium terms. These factors can be summarized as follows:

- income stagnation since 1973 and a significant debt burden;

- the development of collective utilization of equipment; and

- deterioration of currency exchange rates in a market that has become gradually more dependent on imports.

On the other hand, several other factors can be expected to increase the demand for machinery:

- rise in labour costs pressuring for further labour substitution;

- number of farm units decreasing at approximately 3% per annum during the past 25 years, while the total level of arable land has increased, both factors contributing to a significant increase in average farm size;

- increased competitiveness of food production in France vis-a-vis the international markets, further boosted now by favourable exchange rates for export; and

- the intermediate need to replace much of the present machinery, especially tractors, which have become grossly outdated.

If the competitiveness in specialized agro-food production in foreign markets provides an improvement in farm cash flows, a trend to increase investment may also be expected. However, fiscal conditions in the form of lower interest rates for credit must accompany income increases to create the necessary financial conditions for structural changes in agricultural production. As deflationary programs seem to be improving the competitive position on potential markets and forecasts for more comfortable debt servicing schemes are in sight, a machinery replacement and upgrading market may be taking place.

Still, another factor that may help increase the demand for machinery is the labour substitution process that agro-food industries are apt to implement. This industry can be heavily mechanized and automatized. But given the powerful labour resistance that can be expected in the social context of France, labour cutting policies will be hard to implement.

The demand for new agricultural machinery in the Federal Republic of Germany has slightly increased in 1982 from its 1981 level. This improvement is limited to replacement of machinery and is restrained by the growth of second-hand machinery sales. This outlet comprises former rental equipment that dealers placed on the market through leasing arrangements as defensive measures against the market slump during the recession. The ratio of used to new tractors being sold in the market is:

	New models	Second-hand
1979	100	210
1980	100	224

As the stock of used equipment is absorbed and depreciated, new equipment sales will pick up a larger share of the market.

In the medium-term, if credit is facilitated by steady or lower interest rates, the agricultural sector may increase its replacement demand market. The tractor industry is experiencing an earlier recovery than the rest of the agricultural machinery sector. This is true for both internal demand and exports. The export orientation of the German market provides a stable and increasing assurance for the industry. For tractors, the first quarter of 1982 represented a boom market. However, the increase levelled off during the last quarter of the year. Still the years's increase in export was 10.2%, reflecting a record.

A declining home market and a limited international market for Nordic-style agricultural (and forestry) equipment has convinced the Swedish manufacturer Volvo to sharply reduce its production of such equipment. The production of combines has been halted, and the assembly of forestry equipment and tractor manufacture transferred to Valmet in Finland with Volvo supplying only tractor components.

The following Table A summarizes the market outlook in seven Western European producer countries.

The present currency gap between the over-valued US dollar and a relatively weak yen is creating a major comparative advantage for Japanese producers. This is in addition to a built-in cost disadvantage for US and Western European producers due to higher labour and materials cost.

The Japanese government is pushing for increased sale of manufactured goods, including agricultural machinery, to the Middle East oil producing countries because of Japan's heavily negative trade balance with those countries. The Japanese producers are also eyeing very closely the opening up of a potentially vast market in China.

Southeast and South Asia, together with certain markets in Europe will remain the most important export markets for Japanese agricultural machinery.

Table A. Market outlook agricultural machinery industry West Europe - summary table

COUNTRY	1983	Short term	Medium term	Comments
UNITED KINGDOM	- Tractor registration for the first 3 months: +15% - Combine harvesters: +10% in units - Other machinery: no clear expectations - Tractors: 26-27 000 units (26 118 in 1982)	- Overall equipt: increase of 2-4%		- Good competitiveness in foreign market due to weakness of pound and low rate of domestic inflation
FRANCE	- Tractor sales for the first 2 months: +22% - Combine harvesters: +140%	- Domestic market: +1% - Exports: 1-2%		- Total agricultural industry during the last 3 years: +1% - Domestic market: equipment replacement
FINLAND	- Orders: slightly expanding	- Steady market	- Sinking market	- Exports to western countries expanding - Exports to developing countries: small due to big distance between producers and market
DENMARK	- Demand for tractors: increases	- 50% of 1979 sales	- 50% of 1979 sales	- Record level in 1979 - 55% decrease in 1980 - Expected level of stability until 1987: 50% of 1979 sales - Tractor demand: < 50 HP: decrease 50-70 HP: stagnant > 70 HP: increase natural level: 40% of 1979
NETHERLANDS		- Soil preparation and cultivation machine: +10% year - Seeding + planting: +20% - harvesting machines: +8% - Transport equipt: +10% - Farm dairy equipt: +8% - Tractors: +5%		
SWITZER-LAND	- Stagnation			
AUSTRIA	- Increase of 2-4% in nominal terms - Decrease of 0-2% in real terms			
SWEDEN	- No change, compared to 1982			- Bottom reached in 1980-1981

Source: Louis Berger, S.A.R.L., Paris, France.

Of course, small tractors will continue to be sold to North America in large quantities but as discussed earlier, it is doubtful whether these should be considered as agricultural machinery.

3.1.4 The situation in developing countries as it relates to the producers of agricultural equipment in the developed market economies

The manufacturers of agricultural machinery in the developed market economies have, during the recent recession, generally suffered severely in terms of very depressed sales and profit levels. At the same time, the rate of increase in food production is badly lagging behind the rate of increase in population in many developing countries. To close the gap, increased mechanization of agriculture in the developing countries is a must. It has therefore been asked whether the producers in the developed market economies see any solutions to their current problems that would (in some positive way) involve the developing countries. In general, the answer is no.

In this context, it is useful to classify the agricultural machines and equipment into broad groups:

(a) simple handtools
(b) tractors and their attachments, and
(c) self-propelled specialized equipment such as combines.

The producers in the developed market economies do not produce goods belonging to groups (a) and (b) only. But these latter machines are generally ill-suited to the typical smallholder, family type farming of the developing countries. This is so because in the developing countries the farms are mostly very small - only a few hectares - making the opportunity cost of using (family) labour less than that of applying capital extensive farming methods.[36/]

36/ For a detailed discussion of these problems, see "Agricultural Machinery and Rural Equipment in Africa. A new approach to a growing crisis", UNIDO IS/.377.

A possible exception are the tractors and their attachment when used jointly by several farmers as, for example, within the context of a co-operative. Machinery used in rice cultivation might also find an economic use within such multiple-user environments.

Notably, machinery for such joint use by many farmers is often supplied as part of official multilateral and bilateral development aid. Since such aid sometimes is "tied", producers in the donor countries may benefit from such programmes.

With respect to the developing countries, the market situation for North American manufacturers is aggravated by the following causes (in addition to the recession which is still continuing in most of the world, large crops and low farm commodity prices, and high interest rates):37/

(a) North American farm machinery manufacturers are not price competitive;

(b) North American manufacturers are not making what the developing countries want;

(c) problems with distribution, service, and parts supply; and

(d) other problems including red tape in getting US exports licenses, strict foreign corruption laws, and the expense of keeping salesmen abroad because of income tax laws.

To meet the demand for the type of equipment wanted in the developing countries, North American firms have developed new lines of tractors in the less than 100 HP range and typically manufacture them in Europe. Deere is also providing design and manufacturing technology to the People's Republic of China for the production of combines.

37/ These are the consensus views of industry representatives interviewed for this study. In response to queries on how the North American companies are viewing their current market situation and how selling to the developing countries might alleviate this situation.

In 1980, some 173,000 tractors were produced in the developing countries (see Table 4), while total imports were 143,000 units of which approximately 30% were supplied by Western European manufacturers.

Table B below shows the proportion of total production of major producers that takes place in developing countries. Roughly one quarter of the total production is undertaken in the developing countries. To a large extent, this takes place through local assembling of imported, and sometimes locally produced components.

For the European producers, the demand of the developing countries for agricultural machinery represents only some 10 per cent of total production. This amount is considered too small to influence the production trends of these manufacturers.

Political and other unrest in certain traditional markets for the Western European producers of agricultural machinery have made these markets less attractive in the eyes of these producers. Thus, for example, the imports of tractors by Egypt fell from 1,046 units in 1981 to only 48 in 1982; for Zimbabwe, the corresponding figures are equally telling: from 1,052 to 685.[38/] The variation in imports from country to country do not correspond to ordinary economic fluctuations but indicate exogenous intervention in the markets. These are seen by the Western European manufacturers as uncertainty factors and thus have a negative effect on their perception of the markets in the developing countries.

The major segment of the tractor markets for Kubota, as for most other Japanese manufacturers, is in the 20 to 30 HP bracket. As such, the Japanese are aiming their exports at countries with smaller farm sizes not requiring larger tractors. Such tractors, of course, are now also exported to North America, but less so for agricultural purposes.

The relatively weak yen especially compared to the strong dollar, coupled with the fact that Japan produces equipment such as compact tractors, combines and equipment more suited to the developing countries, has given it a definite edge over other developed country producers on these markets. Compact tractors, combines and equipment suited for rice culture constitute the major products aimed at the developing countries.

38/ FAO statistics.

Table B

World and developing countries production of tractors by major firms 1980

COMPANY	UNITS		PERCENTAGE	
	WORLD PRODUCTION	PRODUCTION IN DEVELOPING COUNTRIES	WORLD PRODUCTION	PRODUCTION IN DEVELOPING COUNTRIES
MASSEY FERGUSON	110 650	43 350	100	40,99
INTERNATIONAL HARVESTER	81 350	15 500	100	19,06
FORD	78 900	25 100	100	31,81
J.DEERE	77 200	3 000	100	3,89
FIAT	52 800	4 600	100	8,71
DEUTZ	27 300	6 000	100	21,98
D. BROWN/CASE	27 200	500	100	1,84
VALMET	17 500	14 300	100	81,71
EICHER	12 150	10 600	100	87,2
C.B.I.	7 150	7 150	100	100
EBRO	6 600	1 700	100	25,76
LEYLAND	5 050	1 650	100	32,67
OTHERS	58 400	37 350	100	63,95
TOTAL	662 000	172 800	100	

Source: Louis Berger, S.A.R.L., Paris, France.

3.2 European centrally planned economies

3.2.1 Production

In spite of significant increases in agricultural machinery production in the Eastern European centrally planned economies (CPE's), the domestic markets are not fully saturated either with tractors or other types of farming equipment. The variation in machinery intensity from one country to another is marked (see Tables 40 and 45).

The Council for Mutual Economic Assistance (CMEA) has taken an active interest in furthering the production of agricultural machinery in the region by encouraging a division of labour among the CPE countries.

The international society Agromash was set up in December 1965 in Budapest by the Governments of Bulgaria and of Hungary. In 1969, the Soviet Union joined, GDR in 1973, and Poland in 1976. Within the scope of acitivities of Agromash are problems concerning development, production and trade in agricultural machinery for fruit, vegetable and grape cultivation. In practical terms, Agromash performs intermediatery functions and works out recommendations on problems of co-ordination of plans for design activities, the development of production of agricultural machinery, the introduction of advanced technologies of growing, harvesting, and post-harvest processing of agricultural crops, the specialization and co-operation in the production of machinery, and so on.

The production of tractors in the CPE's of Eastern Europe increased steadily up to 1978. Between 1970 and 1978, the production in number of units grew at an average annual rate of 3.7%. Since then, however, total production has decreased. The production of tractor operated ploughs also shows an increasing trend until the mid-70's whereafter the trend has turned downward (see table 40). In contrast, the production of seeders, harvesters, and combines seems to have reached a plateau in the latter part of the past decade. The best known tractor makes in the region are Zetor (Czechoslovakia), Belorus (USSR), Universal (Romania), Ursus (Poland), and Fortschritt (GDR).

3.2.2 Trade

Both imports and exports of all agricultural machinery grew, in constant values, until 1977-78 whereafter there has been a decline to roughly the level of 1975 (see table 41). Besides engaging in considerable intra-region trade among themselves due to the aforementioned drive for internal specialization, the CPE countries also export tractors and other equipment to many developing countries as well as to some developed market economies.

3.2.3 Co-operation and product specialization by country

In accordance with the stipulants of the "Comprehensive Programme for the Further Extension of Co-operation and the Development of Socialist Economic Integration by the CMEA Member-Countries", the member countries have worked out proposals for extending and expanding the specialization and co-operation in the production of tractors, basic farm machinery, and complete technological lines and equipment. This should take place on the basis of an advanced international machine system for agricultural enterprises employing industrial methods of production. These proposals have been subsequently adopted as guidelines for the next years of the decade.

During 1971-1975, some new and improved types of tractors, farm machinery and machine systems were designed on the basis of the concerted effort of research and design organizations in CMEA member countries.

Bulgaria has specialized in 20 types of machinery. Significant progress has been made in design and production of machinery for soil cultivation in mountain areas. Versatile tractor "Murgash-45" has been used to operate 14 different kinds of machinery for land cultivation, harvesting and other applications.

In Czechoslovakia the production of tractor by the "Zetor" company belongs to the most developed subsectors of the industry. About 70 per cent of the production has been exported to the developing and developed market economy countries. In tractor manufacture Czechoslovakia has co-operated with Poland and Romania on the basis of bilateral agreements.

The sector in GDR has been playing a vital role in joint research and design with the other CMEA member countries.

The Hungarian industry has been able to solve many problems through both its CMEA and East-West co-operation. Examples are the utilization of complementary capacities by the Hungarian Company Komplex and FRG Company Claas in production of combines, harvesters and other types of machinery.

The sector in Poland has manufactured a large spectrum of machines and implements from very simple to technologically sophisticated ones. The wide range is required by the diversity of Poland's farms: from large co-operative or state-owned farms to numerous, frequently small private ones. During the last decade, the Polish industry co-operated both with CMEA countries as well as with Western partners e.g. International Harvester and Massey-Ferguson. The experience has not been altogether positive. Significant increase of production of machinery and implements for small farms are scheduled for 1982-1983.

The Romanian industry has specialized in manufacture and export of tractors. About 300,000 Romanian tractors have been purchased by 86 countries.

Agricultural machinery sector in the USSR is the largest in the region. The sector is scheduled to be expanded and modernized. For 1981-1985 new investments have been envisaged at about $8.8 billion. The investments should lead i.a. towards large scale manufacture of combines "Kolos" and "Niva".

3.3 Latin America[39/]

3.3.1. Characteristics of the Latin American production of agricultural machinery

From 1960 to 1976, the agricultural machinery and implements industry in Latin American countries experienced a self-sustained development with high levels of growth. Thus, from 1962 to 1976, the tractors industry increased

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39/ For a complete survey see "A Survey of the Latin American Machinery Industry", UNIDO/IS. 407.

its production from 18,567 units in the first year to 100,951 units in 1976, representing an average annual rate of growth of 12.9 per cent; similarly, the agricultural machinery and implements industry, other than tractors, grew at an average of 7.0 per cent yearly in the same period.

In 1974, the output of agricultural machinery in Latin America amounted to around one billion dollars. The figure refers to production in the three biggest countries in the region (Argentina, Brazil and Mexico) and in four countries of the Andean Pact (Colombia, Ecuador, Peru and Venezuela) covering 90 per cent of the agricultural machinery manufactured in Latin America.

In the last seven years (1976-1982) there has been a fall in the production as a consequence of international economic developments and in some countries also because of internal problems that hinder the local production. The production of tractors, measured by the physical units produced, decreased at an average rate of 10.8 per cent yearly, and the other branches of the industry decreased at an average of 9.2 per cent yearly (see Table 46).

The tractor industry represents the most important component of the agricultural machinery and implements output in Latin America. Tractors accounted for 57 per cent of the agricultural machinery produced in Argentina, 64 per cent in Brazil and in Mexico 69 per cent. Although the information on production of other agricultural machinery is very weak, it can be ascertained that almost all countries in the region manufacture some agricultural equipment, such as simple handtools and some animal-drawn equipment.

The production of tractors over 10 HP grew steadily at an average annual rate of growth of 23.6 per cent between 1970 and 1976 (See Table 47). In 1977 the production decreased to 89,816 and in 1982 to only 50,663 units, equalling the output manufactured ten years before.

Other agricultural machinery and implements are manufactured in limited quantities by medium and small enterprises and by craftsmen, often in rural repair shops. The relatively simple manufacture of many tools and the advantages of being located near the market have meant that the greater part of these small manufacturers are established in agricultural areas, and accordingly more widely scattered than is usual in other branches of

industry. Products of this type are made not only in Argentina, Brazil and Mexico, but also in Chile, Colombia, Ecuador, Peru, Uruguay and Venezuela.

The economic difficulties during the last two years (1981-1982) were responsible for the decrease in the production and sale levels of the agricultural machinery sector. The economies of the situation is exacerbated by the fact that the Latin American tractor industry is working at a very low level of capacity utilization, only 30 per cent. However, the outlook is improving. In 1983, the tractor production in Argentina, Brazil and Mexico has increased compared to the 1982 production and sales. Thus, Argentina increased its production by 75 per cent in the first quarter of 1983 compared to the same period of 1982.

In 1982, the total tractor fleet in Latin America was 874,189 units. The big countries of the region (Argentina, Brazil and Mexico) had 70.5 per cent of the tractor stock of the region's total of 616,700 units.

As far as harvesting equipment is concerned, the situation is rather different, because the technology is more complex. The main producer of self-propelled harvesters is Argentina, but Brazil also produces this type of machinery. Chile, Colombia and Mexico have some stationery threshing machines. The harvester-threshers fleet in Latin America was 128,723 units of which Argentina, Brazil and Mexico had 95,000 units, or 73.8 per cent of the region total: 44,000 units in Argentina, 36,000 units in Brazil and 15,000 units in Mexico.

3.3.2 International trade of agricultural machinery in Latin America

Import value of current prices agricultural machinery in Latin America increased between 1971 and 1981, but its share in the world imports does not show any significant change.

The import share of tractors is higher than those of other product categories - around 10 per cent. The import share of harvesting machinery shows fluctuations over the years. The share of cultivating machinery has lately decreased reaching in 1981 the level of 1975, around 7.1 per cent (see Table 48).

The export shares show a very different pattern from those of imports. In fact, the global export share of agricultural machinery increased from 0.4 per cent in 1971 to 2.4 per cent in 1981. Tractors have been the most dynamic product: In 1971, Latin America exported 0.3 per cent of the world trade, increasing constantly until 1975 and reached a share of 3.5 per cent of the world tractor exports in 1981. The second item in importance is cultivating machinery which increased its share in world exports from 0.8 per cent in 1971 to 1.8 per cent in 1977 and 1.5 per cent in 1981. In the case of harvesting machinery, the share of around 1% has not undergone substantial changes in recent years.

Total Latin American imports of agricultural machinery reached $650 million in 1981 at constant 1975 prices, up from $445 million in 1971 (see Table 48). This represents an annual real growth rate of 3.9%. Total exports rose to $146 million in 1981, up from $15 million ten years earlier, representing an annual real growth rate of 25.8 per cent. Thus, although imports still exceed exports by a factor of early 4.5, exports grew at a much faster pace than imports. Even more remarkable is the indication that the recent recession appears to have affected imports much more severely than exports which remained in 1981 at about the 1980 levels, or even increased slightly for some product groups, whereas imports in all product categories decreased dramatically (see Table 48).

The importance of export promotion of manufacturers by the most developed countries of the region is evident in the evolution of the import and export figures for agricultural machinery. The ratio of imports to exports dropped from 30.1 in 1971 to 4.4 ten years later. Among the product groups, the change in imports in relation to exports is most significant in the case of tractors: the ratio declined from 49.9 in 1971 to 12.5 in 1975 and to 3.4 in 1981.

3.3.3. Prospects for expanding the Latin American agricultural machinery and implements industry

In Argentina, farm machinery sales increased nearly 50 per cent in 1982 from the very depressed level of 1981. In Brazil, despite the government's

Strategic Development Plan, farm machinery sales in 1983 are likely to remain near depressed 1982 levels. In Mexico, severe national financial problems will continue to limit farm machinery sales in 1983.

In the medium term, there are potentials for the further development of the agricultural machinery and implements industry in Latin America due to the following main reasons:

(1) There is a serious crisis in the availability of food products, in many developing countries.

(2) Latin America, having large areas of underutilized or not yet utilized land, is the biggest land based world reserve for food production.

(3) Latin America can reach a substantial improvement in its agriculture productivity through an intensive process of agricultural mechanization 40/.

(4) The rate of use of animal drawn power is decreasing sharply, specially in the more developed countries of the region.

(5) Governmental institutions have granted a high priority to the development of the agro-industry sector.

(6) There are in the more developed countries a high technological level, experience and capacity to export and transfer technology to the less developed countries.

(7) Regional and sub-regional agreements will promote interregional trade and horizontal integration.

(8) Packages of promotion measures, giving incentives to industrial development, exist in the Latin American countries.

40/ In the Federal Republic of Germany, labour productivity increased 5.5-fold from 1950 to 1974 due to increased mechanization. This example illustrates the magnitude of the potentials.

(9) The institutional facilities for financing of both production and exports are good.

(10) The most promising cost-reducing policy in the agricultural economy is through an intensive use of agricultural machinery and implements.

In order to accelerate the development of the agricultural machinery and implements industry in Latin America, it will be necessary:

(1) to standardize the production of agricultural machinery and implements through adequate national, regional and international co-operation; (national and regional institutions for technical standardization together with similar institutions of the developed countries can help the sector reach the necessary standardization);

(2) to raise the presently very low level of capacity utilization to improve true economic viability;

(3) to promote co-operation of manufacturers of agricultural machinery at national levels in order to reduce marketing costs and to have a competitive export package;

(4) to establish a Latin American network of technical and commercial information on agricultural machinery and implements industry in order to improve production and sales;

(5) to promote an adequate technology transfer to the less developed countries through international co-operation;

(6) to improve the horizontal integration through regional agreements and international co-operation; (sectoral meetings of manufacturers can help this purpose);

(7) to promote national and regional seminars and training courses with participation of users or potential users of agricultural machinery and implements, specially in the less developed countries;

(8) to promote in the less developed countries national institutions of technical assistance in agricultural machinery, similar to those existing in the more developed countries of the region; and

(9) to make farming itself more profitable thus encouraging increased productivity through higher levels of mechanization. This can take place through a variety of schemes such as long-term tax incentives and buy-back schemes, subsidized loans, export incentives, etc.

3.4 Asia[41/]

3.4.1 The ECWA region

Information concerning the ECWA region (Bahrain, Iraq, Jordan, Kuwait, Lebanon, Oman, Qatar, Saudi Arabia, Yemen Arabic Republic, People's Democratic Yemen Republic) has been given by the ECWA secretariat. Available fragmentary data indicates that the agricultural machinery industry, as far as ECWA is concerned, can be considered significant in Iraq and Syria and there are some possibilities for expanding the fleet of agricultural machinery and equipment in Saudi Arabia and Jordan. (See Table 49 for the number of tractors in use in the countries of the region from 1965 to 1980).

The Council of Arab Economic Unity has taken an active role in co-ordinating and integrating the AMI in the Arab world. A project protocol was prepared in 1982, which among other things, calls for the co-ordination and integration of production programmes as well as co-ordination of plans for establishing new production units or expansion of existing ones through joint venture companies.

In both Iraq and Syria, the manufacturing of simple equipment and tractor assembly have started. In Saudi Arabia, the development of this industry is based on national components but most of the inputs such as spare parts and production equipment have to be imported.

41/ Excluding Japan which is discussed under Developed Market Economies.

In Iraq, a great number of the machinery is idle due to poor maintenance and lack of spare parts. In order to reduce the number of idle machines, extensive steps have been taken to build workshops equipped with spare parts all over the country. Furthermore, mobile workshops have been purchased to provide service at sites in isolated areas.

The State Company for Mechanical Industries in Iraq started in 1970 assembling Russian implements such a ploughs, harrows, planters and other. Tractors assembly started in 1977 with the Czechoslovakian Zetor (renamed Antor). The period 1981-1985 is considered by Iraqi authorities as an advance mechanization stage. During this stage, all grain crops as well as a reasonable percentage of other crops are supposed to be mechanized. By 1995, Iraq is aiming of completing full mechanization of all cereals as well as a very high percentage of industrial crops, fodder and vegetables. If the targets are achieved, 0,8 HP/hectare may be exceeded. With regard to manufacturing, the intent is to manufacture all implements required and to meet the local demand of 70 HP tractors. This size of tractor represents more than 80 per cent of all types.

Steps have been taken to enlarge the production capacity of tractors in Iraq to reach 5000 units per year. The local content is aimed at reaching 55 per cent of the cost of a tractor. This may be achieved easily when the new premises for assembly and manufacturing of tractors are completed. The local content in manufacturing implements is in advanced stages and it is intended to reach a 95-100 per cent local content in the near future.

With regard to import policy, it is intended to minimize makes and models. In 1968, there were more than 60 different makes of tractors in Iraq. This has been reduced to about 30 by 1978. More efforts are made to reduce the models to a minimum.

The only local production unit for tractors and agricultural implements in Syria is the Al-Furat factory in Aleppo. This is a joint venture between Motor IBERICA S.A. of Spain (25 per cent) and the Syrian Government (75 per cent). The Al-Furat factory was established in 1973 and the assembly

started using imported 60 HP engines. Later, other models were introduced but since 1980, the production has been rationalized to a single 70 HP tractor. Annual output of traders was raised from 217 units in 1974 to 3,000 units in 1982.

The Al-Furat factory started assembling imported units from Spain. Now it is claimed that about 50 per cent of the cost of a tractor is manufactured locally through the four workshops that have recently been completed. The planned local manufacturing programme is aimed at 4,500 tractors, i.e. about 50 per cent than what was planned. Steps are also taken to increase local content to reach at least 55 per cent.

There exist private plants to manufacture implements such as planters, threshers, sprayers, spreaders and others. The operation in these plants is artisanal and the production is to order.

The newly established State Organization for Agricultural Mechanization intends to act as a co-ordinating body and to achieve the level of mechanization required by the development programmes including the co-ordination of demand and supply. But presently, the organization is implementing projects related to repair and maintenance centres and the projects related to the mechanization of certain crop fields. The tractor utilization is aimed at 85 hectares per tractor by the year 2000. This appears to be an ambitious target.

Available data for the ECWA Region do not distinguish between domestically produced and imported machinery (see Table 49). However, FAO data indicate that the majority of at least Iraqi tractors, and probably most of the other machinery as well, is imported. The number of tractors have increased nearly 3-fold between 1971 and 1980. The increases in harvesters, combines and weeders are also significant.

Turkey and Iran both had substantial markets until present financial and political problems suspended production and trade. However, in Turkey, farm machinery sales increased significantly in 1981 and 1982 and should be stable or slightly higher in 1983. The situation in Iran remains depressed.

The assembly plant capacity in Turkey is about 40,000 units (Fiat, Massey-Ferguson, Ford, International Harvester, and Leyland) and Iran 12,000 units (Universal/Massey-Ferguson, and John Deere).[42/]

For Turkey, the following additional data for tractors are available:

	Park	Output	Sales
1970	104,640	7.709	...
1975	220,000	34.281	52,000
1977	300,000	43.560	60,000

The Middle East oil producing countries are expected to remain a relatively strong market for agricultural tractors. However, government priorities are likely to affect sales level. The present war between Iran and Iraq is creating major uncertainties and is siphoning off resources, affecting all industrial operations in those countries.

Lowered income from oil dampened both actual sales and planned acquisitions of agricultural machinery in the whole region. The prospect for an increase in oil revenues in real terms over the near and middle term is slim at best.

3.4.2 The East Asian Region

The information contained in this summary has been provided by the ESCAP Secretariat. ESCAP has established an inter-country project entitled "Regional Network for Agricultural Machinery" (RNAM) which has had a far reaching effect and impact on the agricultural mechanization programme in the participating countries. Particular attention has been paid to the strengthening of manufacturing capabilities of the developing countries.

42/ "Tractors in Use and Markets Worldwide", Agricultural Machinery Journal, May 1979.

India

There are 700 manufacturers in large and medium-scale, 1,500 in small-scale and about a million village artisans and blacksmiths. The products range from four-wheel tractors to hand tools. No implement or machinery is now imported, as the required technology, equipment and raw materials are available locally. To promote local manufacturing, District Industry centres provide technical guidance, shed land and other facilities. State financial corporations provide loans at subsidized rates, particularly for backward areas. Some of the important materials are provided by Government agencies to small-scale industries. Most of the other materials are freely available from the open market. Marketing by bigger manufacturers and urban-based units is through dealer network and the medium and small-scale manufacturers through their own efforts. The larger units and their dealers have adequate competent staff for after-sales services while smaller ones usually attend to complaints at their own workshops. The large industries have adequate quality control methods while the smaller ones also apply quality control to some extent. There are many research organizations working for research and development of agricultural implements and machinery. Indian Standards Institution has already laid standards for a large number of agricultural implements and machinery.

Contrary to the commonly hold belief that very long series are essential because of economies of scale, Indian plants are all set for productive levels between 3,000 to 7,000 units of equipment per year. This set-up is better suited to India's low wage cost structure and small regional markets than the pattern with high capital intensity and high degree of automation typical of the production in the industrialized countries.

Indonesia

The growth of manufacturing industries in the country is increasing due to positive Government programmes and policies in promoting agricultural mechanization, support from universities and scientific organizations, increasing national rice production, which create big demands for agricultural machinery, and steps to control imported machines through an import tax and duty for agricultural machinery which is differentiated by the level of manufacturing.

Pakistan

All the tractors and farm machines were imported in the first decade of Pakistan's creation. Since then the imports have gradually given way to local production. A variety of implements is also imported from Europe and the US. Five makes of tractors, i.e. Massey-Ferguson, Fiat, IMT, Belorus and Ford are being imported and assembled by two firms in the public sector and three private firms using some local parts. The Government has laid down a strict deletion programme for all the firms engaged in tractor manufacturing to gradually increase the volume of local parts,. They are to achieve 85 per cent deletion in these tractors by 1985-1986.

There are nearly 400 manufacturers of agricultural machinery in Pakistan. Of these, about 10 can be considered as large, 100 as medium and the rest as small-scale manufacturers. There is a large variety of farm machinery being produced in the country. Only cultivators and threshers are produced in large quantities.

There are two Agricultural Engineering Institutes, exclusively engaged in the development of agricultural machinery and farm implements in the country.

The Government of Pakistan has provided several incentives to the manufacturers of agricultural machinery such as exemption from income tax, refund of custom duty for raw materials used for farm machinery production. These incentives have had a positive impact on the local manufacture of farm machines.

Philippines

Sales of agricultural machinery and equipment totalled $74 million in 1979, $40 million in 1980 and $61 million in 1981. Locally produced agricultural machinery had a share of 10 million in 1979, $7.4 million in 1980 and $9.0 million in 1981. The Philippines imported $32 million worth of agricultural machinery and tools in 1979, $26 million in 1980 and $29 million in 1981. The United Kingdom and the US were the main suppliers of standard four-wheel semi-knockdown condition tractors, while Japan almost monopolized

the supply of four-wheel compact tractors. The US was the major source of gasoline engines, while Japan and Italy shared the bulk of diesel engines imported from 1979 to 1981. Japan and China were the main suppliers of rice mills.

Most of the agricultural machinery manufacturers have shops equipped with the basic metal forming, cutting, welding and machining equipment. There is paucity of heat treatment facilities for special materials like spring tines for multiweeders. There are about 80 manufacturers and assemblers of agricultural machinery and equipment. The industry employed about 6,200 people in 1980 and produced about $26 million worth of agricultural machinery.

The Government through the Board of Investments and other government agencies formulated policies, programmes and incentives towards local manufacturing. An Executive Order creating the National Agricultural Mechanization Council has been drafted. The Bureau of Standards has started setting minimum standards for farm machinery and equipment. Already, standards have been set for threshers, rice mills, grain driers, and corn shellers.

Though a big number of gasoline engines are imported, the share of the diesel-powered equipment is now increasing.

Sri Lanka

Endeavours are being made to instruct the farmers on the use of modern farm machinery and implements. Most of the farmers have small holding and so their financial capacities are limited. High prices for fuel and spare parts are constraints in the popularization of power machinery. Therefore manual and animal-drawn implements will have to be improved and popularized.

There is a liberalized import policy in Sri Lanka. Four-wheel tractors and power tillers are imported mostly in built-up stage. Some implements for the above are imported as accessories while other implements for tractors, power tillers and animal-drawn implements are manufactured locally. Hand tools are manufactured at the rural level. Transplanters are in the R & D stage. Rotary weeders are in use. Gasoline, diesel engines and two stroke

engines are imported and used on water pumps and sprayers. Mini-axial flow threshers are manufactured in small numbers. Machines imported which compete with some locally manufactured farm machinery and implements have a high (protective) tariff. Prices are closely watched by officials of concerned ministries.

The liberalized import policy is a challenge to local manufacturers to upgrade their products in quality and finish. However there is the ever prevailing problem of importers and aid giving organizations bringing in cheap, unsuitable type of machinery and equipment with no after-sales service facilities. This has adverse effects on local manufacture. There is growing linkage between manufacturers and research institutes. Moves are being made to establish an Agricultural Machinery Manufacturers Association.

Thailand

The significant locally manufactured agricultural machinery in Thailand are (i) power tillers, (ii) mini tractors, (iii) low lift irrigation pumps, (iv) farm trucks, (v) rice threshers, and (vi) rice mills. Important items imported are: (i) farm tractors from U.K, (ii) mini tractors and power tiller from China and Japan, and (iii) small diesel engines and water pumps from Japan.

Republic of Korea

Although a significant producer of certain agricultural machinery, specific statistical and other information is lacking at this point.

3.4.3 Common problems in Asian countries

Common problems facing more than one Asian Country are:

1. Facilities for providing information on modified designs and prototypes are inadequate.

2. Lack of experience in the marketing field for some (mostly small) manufacturers.

3. Strong impact of imported agricultural machinery on consumers.

4. Raw materials are often hard to get which make the price go up.

5. Difficulties in obtaining credits for financing.

6. The alloys of steel, aluminium and copper of reliable composition and physical properties in all commercial shapes and forms are not readily available on the open market. The availablitiy of sub-standard, raw materials imported by traders at cheap rate has retarded the growth of steel industry.

7. Shortage of trained engineers and technicians in the country due to draining out of these essential personnel to Middle Eastern countries because of better wages.

8. Deterioration of technical education standards at the educational institutes.

9. Inconsistent and seasonal demand for the farm machines which discourages investors to enter this industry.

10. Farmers are not quality conscious. They prefer to purchase implements at the lowest price even if they are of inferior quality. This is a serious drawback in improving the quality of farm machines produced locally.

11. Lack of sufficient marketing and export outlet organizations.

12. Higher production costs caused by low productivity, wastage and inferior production techniques, partly due to minimal production planning and control.

13. Difficulty in marketing of farm implements due to poor knowledge about use and maintenance of farm machines produced by the manufacturers of the farm machines.

14. Lack of co-ordination among the training institutes to train farmers, operators, mechanics, artisans, and middle level technical supervisors and engineers to utilize the existing training facilities to their best possible potentials.

15. The manufacturers have been encountering problems with foreign competition since tariffs for imported finished farm machinery and equipment are kept low but tariffs for raw materials for the manufacture of the same implements are kept high.

16. Lack of after-sale service.

3.5 Africa

3.5.1 General outlook[43/]

Industrial producers of agricultural machinery in Africa[44/] are few in number, mostly small in size and able to make only a correspondingly small contribution to total supply. In all developing Africa, there are only about 100 industrial or semi-industrial companies, even including those for which agricultural machinery and equipment are not the main products. As a rough estimate, they employ 15,500 workers to manufacture equipment valued at $150 million and with a value added on only $50 million annually.[45/] Adding $150 million to the estimated value of imports, $850 million, (average annual value in the period 1978-80), gives a market estimate of around $1 billion.

The local producers' share (the rate of self-sufficiency) is thus 15 per cent based on final value and only 5 per cent based on added value. The situation is, of course, worse if the sub-Saharan countries are considered

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43/ This summary report is largely based on the survey "Agricultural Machinery and Rural Equipment in Africa. A new approach to a growing crisis". UNIDO/IS. 377.

44/ As a developed country, South Africa was not included in the study.

45/ Because of the paucity of available data, it is only possible to make rough estimates based on average added value per worker. The quoted figures nevertheless indicate the general order of magnitude.

alone, e.g. excluding Algeria and Egypt, respectively Nos. 1 and 2 in African agricultural machinery production.

Generally, each of the small and medium-sized countries has only one industrial producer,[46/] that evolved in response to a wide variety of local conditions. Because of history, local environment and national policies, industrial producers therefore show strong national traits and focus almost entirely on local or national markets. Exports of finished products or components of agricultural machinery between the countries are virtually unknown.

Nearly all the industrial units in the sector were set up during the period 1950-1972, some even earlier. In many cases their equipment is old. In recent years only a few new units have been established; at the same time many either disappeared, amalgamated with others or abandoned production of agricultural equipment in their manufacturing programmes. Today, only about one third of the companies produce exclusively agricultural equipment. The others can be divided into two groups:

(1) Producers whose dominant activity is still agricultural machinery but that have diversified production by adding one or more product lines offering higher profitability. The range of equipment may include stationary equipment for the agricultural and other sectors, wheelbases and other transportation equipment, and metal furniture. The non-agricultural machinery products often account for a significant part of the turnover.

(2) Producers coming from outside the sector. Examples are industrial groups in metal working (roundries such as Chanimetal in Zaire), in engineering (Sonacome in Algeria, Acmefon in Zaire, Sidema in Madagascar), in vehicle production (Nasco in Egypt), and importing companies such as

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46/ Despite the distinction made here between industrial and artisan production, a rigorous classification is not possible in practice because of the wide diversity in the types of production unit. The co-operatives of artisans that have evolved in Western Africa have clear industrial characteristics, for example. With that proviso, countries apparently without any industrial-scale capacity for agricultural machinery production are [illegible] Central African Republic, the Congo, Gabon,

Fiat-Zaire. Such groups are often of considerable size and influence for the country. They are linked either to state interests, or (as private companies) linked to transnational corporations. Table C presents the main characteristics and limitations on agricultural mechanization in Africa.

Whether or not it is agricultural machinery or other goods that dominate, the range of equipment produced is nearly always very broad due to the limitations of the market for each product in most African countries. Each manufacturing enterprise has had to diversify production into other products.

The situation of Africa's agricultural machinery producers has worsened by the effects of the world recession since 1980 and the deterioration of many African economies. The rising cost of imports, which represent up to 70 per cent of the total cost of many products, increased the overall cost of African-made agricultural machinery and was the source of the sector's falling local added-value component. If producers tried to pass on these costs, they exceeded their customers willingness to pay. If their selling prices were frozen, there was a corresponding reduction in their own margins and therefore in their own investment capability. Lack of investment meant foregoing not only new capacity but also the many small items necessary for immediate improvements in productivity.

These trends are aggravated, depending on location, by falling or stagnating farmers' incomes, by reduction or cancellation of state aid to industry and by increased competition from companies in developed countries---especially the world's large producers confronted with recessions in their other makets.
The fall in farmers' incomes often reflected a parallel crisis in the agricultural sector--the results of drought and government policy measures (e.g. stagnation in agricultural product prices). Some governments also had to reduce their aid to industry because they in turn were confronted with high indebtedness. They may also have had to reduce credits because of cuts in bilateral and multilateral aid.

To these difficulties outside the industrial producers' direct control are added the deficiencies specific to indivudual firms--in particular their low technical ability, their low productivity and systematic errors at the

TABLE C. CHARACTERISTICS AND LIMITATIONS ON AGRICULTURAL MECHANIZATION IN AFRICA

Characteristics	Hand farming	Animal-draught farming	Tractorisation
System basis	Man-dependent, using human energy to accomplish all tasks, either directly or with the aid of simple traditional tools	Use of animals to carry out all or part of the agricultural work. Implies complementary agriculture, husbandry system and use of animal-drawn equipment	Use of motors and tractors to carry out all or part of the agricultural work Requires corresponding environmental and other changes to permit operation of machines and heavy equipment
Machines used	Simple tools (machettes hoes) Simple machinery to be carried (back-pack sprayers), pushed (carts, hoes) or stationary (shellers, pumps)	Simple machines (carts swing-ploughs, harrows) More sophisticated machinery-ploughs, sowers, multi-cultivators)	Tractors with heavy equipment (ploughs, disc harrows, sowers, drills, trailers) Motorized fixed machinery (threshers, motorized pumps) Self-propelled machines
Initial investment	$10/labourer/5years for simple handtools; less than $100/labourer/5 years for simple machinery	$325/decade plus rearing and training of animals; $400/animal for purchase	Equipment cost (including one 45 hp tractor) estimated at $11,000/8 years; $16,000 if thresher is included
Positive aspects	Low level of investment with direct supply from local blacksmiths System is adapted to the agro-ecological environment (e.g. cultivation on ridges with several types of plants on the same plot) Conditioning of land confined to contol of water No training needed	Animal-draught farming eases bottlenecks in soil preparation transportation Low investment cost; investments made profitable by increases in production Land conditioning made feasible (grubbing and land clearing) Maintenance by local artisans and blacksmiths Production by craftsmen or local industry does not need major investments in equipment The low degree of complexity requires little supervision The system adapts to the agro-ecological environment without disturbin it	Introducing heavy mechanization raises value of waste land production, increases output by expanding arable land, carries out arduous work such as deep tillage and raises the value of inputs by introducing modern farming techniques Very high appeal of tractors, as symbol of modernity Can compensate for a lack or absence of farm labourers.
Agricultural operations performed (role of equipment)	Partial clearing Light preparation of soil (surface only) Crop maintenance and plant protection Aid to harvesting and products transformation	Light preparation of soil; sowing; upkeep of cultures; light transportation	Preparation of soil, sowing, light tilling, transportation. Via accessories: threshing, irrigation
Types of crops affected	Food crops: cereals, roots or fruit; cash crops: annual (cotton, groundnut); perennials: palm trees, sugar cane; export crops: coffee, cocoa, citrus fruit	Cereals: rice, corn, millet, wheat; annual cash crops: cotton, groundnut, tobacco	Cereals: rice, corn, wheat; cash crops: annual (cotton, soya); pluriannuals: (sugar cane, bananas); perennials: (palm trees, coffee, cocoa)
Disadvantages	Low productivity	Because of the limited strength of the animals and the present technological limits, only a few farming techniques and crop types can profit from mechanization, especially among tuberous food crops	Some operations, e.g. transportation, easily mechanized; others require treatment of land (land clearing, anti-erosion terrassing) or a change of farming technique (e.g. flat instead of line culture) Some harvesting operations mechanized only with difficulty
Type of farmers and farming units	Small individual family-type farming (less than 5 ha), medium and large plantations where much work is still manual	Individual medium-size family plots (less than 20 ha) usually based on cereal	Medium or large size farming of cereals or industrial crops: . family farms of more than 20 ha . large private farms . private, mixed or state agro-industrial units . state farms . production co-operatives
Problems		All non-mechanized work still done by hand; some deep tilling is motorized	Mechanization rarely 100% - in general limited to a few operations; the remainder require human labour
Present limits and bottlenecks	Simple handtools mean low productivity and no progress beyond subsistence level; Young people refuse to continue working with traditional methods (arduous and demeaning tasks); General lack of equipment especially for harvesting, storing, processing and transport	Low productivity level reflects strength of animals; several operations (e.g. tuber farming cannot be mechanized) Stock raising requires grazing areas or fodder crops Credit to purchase animals and equipment granted only to co-operatives and in framework of development programmes Need to set up supply systems for spare parts and maintenance Low level of interest shown by young people whose ambition is modernization through motorization Geographical limits: animal-draught farming is limited to areas of traditional animal husbandry, flat regions with only slight infestation of parasites, a few types of farming (harvesting constitutes a particular bottleneck) [illegible] compet[illegible]	Lack of local manufacturing; import problems for poor countries; Weak infrastructure (maintenance and distribution networks hard to establish) Badly prepared territory: lack of land clearing and anti-erosive terrassing Little adaptation of equipment and techniques farming for Africa conditions particularly for food crop farming Farm credit systems not adapted to purchase of equipment Low productivity due to farm size and plot distribution (in particular with food crop farming) Low income of family production units Increasing divergence between equipment cost and prices of agricultural products [illegible] High operating costs

Source: [illegible]

deficiencies in areas of employment and wage levels. This leads to short-term decision making and management strategies that move production and marketing in entirely the wrong direction. For example, many of the companies are seeking solutions to their problems by developing exports, the fruits of which are often illusory.

3.5.2 Imports

Although they provide only an incomplete record of current trends in imports, import statistics for agricultural machinery in Africa confirm that the continent is a relatively small buyer on a global scale, (see Table 52). Furthermore, the general trend seems to be down rather than up, with most countries spending progressively less on imported equipment. In world terms there are differences too in the pattern of imports--with Africa showing a greater than average emphasis on tractors (see Table 54). At the same time most African countries continue to purchase large quantities of foodstuffs (e.g. commodities such as cereals) and non-machinery agricultural inputs such as fertilizers. The overall picture, therefore, is that agricultural machinery receives low priority in external spending.

Import data for agricultural machinery and handtools (Table 51) for the period 1973 to 1979 shows a rapid increase in volume up to 1975 followed by a series of erratic moves in the second half of the decade. The huge drop in 1979, over 33 per cent, brought the value of imports below 1975 levels and, because of inflation in between, reflected an even larger drop in volume.[47/] This is in line with the reports of domestic suppliers for the same period, i.e. the market plunged for importers and local manufacturers alike.

As a market for the world's agricultural machinery suppliers Africa's 5 per cent share (Table 52) is small in relation to its population. Handtools aside, the major suppliers are European countries (with 72 per cent) followed by the United States (with 15 per cent) (Table 53). Intra-African trade (6 per cent) is small by comparison and South-South suppliers (2 per cent) are almost negligible.

47/ Later estimates from UNECE (Geneva) and the Comité Européen du Mechinisme Agricole (CEMA, Paris) indicate a modest recovery in import demand in 1980 and 1981.

Within Africa, the North Africa subregion accounts for 50 per cent of the developing countries' demand. This is followed by Eastern and Southern African with 23 per cent and West Africa with 20 per cent. Central Africa accounts for only 8 per cent of total imports. Individual countries accounting for a significant share of total imports include Algeria (around 6 per cent), the United Republic of Cameroon, Sudan and Kenya (4.5 per cent) and the United Republic of Tanzania (4 per cent).48/

Case studies for 16 countries selected for special study49/ confirm three things:

(1) The levels of production is low in all countries and declining in certain countries;

(2) Changes in imports, in particular of tractors are erratic: the trend is generally downward, reflecting disorganization and external disruption of markets;

(3) Motorized equipments--tractors and their associated equipment, in some cases also combine harvesters--dominates the volume of imports of each country.

3.5.4 Short-term prospects

Only a few African countries have so far recognized the important role of domestic producers by supporting expansions of existing capacity and/or plans for new production units. The result of 16 countries studies, are summarized in Table D.

48/ Unless otherwise stated, statistics and other references to Africa in this report should be understood as "developing Africa". In this context, the continents' main importer is South Africa whose $214 million purchases in 1979 equalled 44 per cent of those by developing Africa.

49/ See Annex II of Agricultural Machinery and Rural Equipment in Africa, op.cit.

TABLE D. PLANS FOR NEW INVESTMENT
(as of mid-1981)

Countries investing in existing plants	Notes
Algeria Togo Zambia	Algeria plans to extend the Constantine complex to a capacity of 1,000 tractors per year and 4,000 motors/year. The Sidi Bel Abbes complex will be expanded by 500 combine harvesters per year. In Togo, Uproma, created in 1980, will be further developed. Tropic in Cameroon is considering adding a foundry. In Zambia, Northland Engineering is considering an expansion that would include production of animal-drawn equipment, handtools and tractor equipment. In addition a feasibility study has been made for a tractor assembly unit.
Countries planning new production units	
Mali Nigeria United Republic of Tanzania United Republic of Cameroon	In Cameroon the enterprise Anghu in Bermanda is building a new workshop for stationary equipment. Mali is considering a small unit for assembling threshers and other stationary equipment. Nigeria is planning to add tractor assembly at its plants for vehicle assembly. Tanzania plans a 4,000 t/a unit for handtools, equipment for animal-drawn cultivation and tractor equipment at Mbeya: the finance comes from Holland the technology from India. A similar mixed product project at Mwanza, built with help from Bulgaria, will have a capacity of 6,700 t/a. A tractor assembly unit with a capacity of 1,500 units/year is being built in conjunction with Valmet company (Finland); the UFI company is expanding capacity to 1,000 t/year.
Countries with no known new projects	
Burundi Chad Egypt Ethiopia Kenya Senegal Sudan Uganda Zaire	In Senegal, Sismar, which ceased operations in September 1980, resumed production in early 1982. In Burundi, a handtools plant at Bujumbura has not operated after being built in 1972. In Uganda, two modern handtools plants ceased operation due to the war situation. The Somat unit in Chad has not started up for similar reasons. In Sudan, the Masudan assembly project to make 4,000 tractors/year, first considered in 1974 is blocked for lack of finance.

This information, although fragmentary, permits four broad conclusions.

(1) Eight countries out of sixteen studied have no known project for agricultural machinery.

(2) The creation of sizable new industrial units seems to be confined to Nigeria and the United Republic of Tanzania. In this context, Tanzania, one of the least developed countries, joins a restricted group of more advanced African developing countries (Algeria, Nigeria and the United Republic of Cameroon), all of which anticipate substantial investment in the agricultural machinery sector.

(3) All new or expanded projects are to some extent multiproduct. Tractor assembly, for example, is usually associated with the assembly of other heavily--motorized equipment (e.g. passenger vehicles and trucks, military vehicles). Finally, no project is exclusively devoted to industrial manufacture of handtools, apart from the scheduled restart of an existing unit in Burundi.50/

The picture provided by these individual national projects is partly explained by the economic difficulties outlined earlier. The number of projects recently abandoned has been extremely high. Today there are more firms, whose sole objective is to ensure their own survival, than companies envisaging investments, not to mention those whose existing units are inactive.

In summary what has happened is that the industrial basis of agricultural machinery production in Africa, which was created and developed between 1950 and 1974, has experienced a break in rhythm and direction. Instead of helping satisfy basic food needs and make the African countries self-sufficient in agricultural machinery, the trend is in precisely the opposite direction.

50/ In Sudan a project drawn up in collaboration with China has been abandoned.

It is clear that the agricultural machinery sector labours under a number of heavy constraints. Overcoming them has to become a priority task for national governments.

Local industrial scale production is generally limited to one or two producers per country and in many countries does not exist at all. These producers, moreover, are medium or small size (rarely more than 200 employees) whose output is either confined to simple technical operations, or constitutes only part of a multiproduct range. In many cases there is only minimal contact with the existing industrial environment and the resulting difficulties in obtaining local supplies of raw materials and semi-finished goods means continuing dependence on overseas supplies. In turn, this means transport difficulties, late deliveries, long lead times and a general inability to compete with imports of finished goods.

Craft producers are also suffering from increasing imports but there is growing competition from higher quality industrial products made locally as well. Furthermore, the contribution made by local blacksmiths in rural areas, although high, has never been quantified and as a result tends to be ignored by central authorities responsible for finance and agro-industrial development.

In addition to these individual problems both groups operate in an economic environment that hinders rather than supports their development. Imports, competition from local industry and farmer credit geared to purchases of industrial products undermine the precarious existence of artisans and blacksmiths. Competition from imports, supply difficulties and declining farmers' incomes have markedly reduced the turnover and output of the smaller industrial producers.

Given the apparent overcapacity, there has been little interest in developing new industrial projects. Similarly, private investors find little encouragement in the weakness and irrationality of the market as a whole. On the other hand, development of this sector in each African country is vital not only to supply equipment and maintenance services to agriculture, but also to minimize dependence on overseas supplies.

3.5.4 Mid-term prospects[51/]

In 1978, African cereal imports had already reached 13.4 million tons, a level that was not supposed to be reached until 1990.[52/] According to an FAO study,[53/] in the year 2000, Africa will need 39 million more tons of rice and coarse grains than in 1980. Consequently, cereal production has to be intensified urgently. Here industry has a vital role to play, particularly since it provides industrial inputs into increasing production and reducing food losses. However, given the broad potential contribution of industry to agriculture and in view of the limited industrial capacity, coverage is highly selective: specific choices would depend on each country.

The manufacture of simple hand tools is fairly well established in most African countries at the village blacksmith level and, in some countries, higher engineering levels have been achieved. However, in most African countries, the local manufacture of animal-drawn and power-operated implements is still virtually non-existent. The same situation exists in respect of such inputs as storage and processing equipment, and industrial machinery and equipment.

Agricultural tools

Total imports of agricultural tools in the African region were of the order of 40,000 tons in 1976, and it is estimated that they will increase to 139,000 tons and 207,000 tons by 1990 and 2000, respectively. Current annual production capacity is about 18 million hand tools and 60,000 implements. By 1990, the Eastern and Southern African subregion will require over 7 million hand tools. The corresponding figures are over 10 million hand tools for Western Africa, and 3 to 4 million hand tools for North Africa. The Central African subregion will most likely be able to manage by upgrading existing and planned establishments.

51/ Based on United Nations, A Programme for the Industrial Development Decade for Africa, New York 1982.

52/ FAO, Regional Food Plan for Africa, Rome 1980.

53/ FAO, Agriculture: Towards 2000 (C79/24), Rome 1979.

Hand-operated and animal-drawn implements

Total demand for 1990 and 2000 is estimated at over 25,000 tons and 38,000 tons respectively. About 10 per cent of these requirements are for Central African countries and 30 per cent each for the other three subregions.

Power-operated agricultural implements and machinery

Total regional requirements for these implements and machinery are estimated at 75,000 tons and 100,000 tons for the years 1990 and 2000, respectively. Their distribution would be similar to that for hand-operated and animal-drawn implements. Very few African countries have manufacturing facilities for these implements and machinery, whereas about a dozen countries have facilities for assembling power-operated implements.

Agricultural tractors

In 1977, a total of 83,433 tons of agricultural tractors were imported into the region. It is estimated that this will increase to 687,000 tons in 1990 and 1,750,000 tons in 2000.

The following are among the activities that need to be undertaken:

(a) The formulation of an agricultural modernization and phased mechanization policy and strategy based on self-reliance, taking into account the changes in the farmer's income levels, farm sizes, power requirements and energy needs as a basis for a farm input development programme;

(b) Design and formulation of an appropriate farm inputs development programme and identification of major changes in demand for inputs, including standardization, so as to extend the domestic market and develop maintenance services and the production of spare parts;

(c) Support for and upgrading of indigenous agricultural agents and rationalization of production;

(d) Preparation of fertilizer and pesticide programmes, including manpower profiles.

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